DEVELOPMENT OF A SELF-RATING SCALE FOR TELEPHONE COMMUNICATION ABILITIES OF INDIVIDUALS WITH HEARING LOSS

By

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TABLE OF CONTENTS

ACKNOWLEDGMENTS ii

ABSTRACT vii

CHAPTERS

1 INTRODUCTION AND REVIEW OF THE LITERATURE 1

- Introduction 1
- The Telephone 3
- Hearing Aid to Telephone Coupling Strategies . . . 4
- Aural Rehabilitation and Telephone Use 8
- Current Methods of Evaluation in Aural Rehabilitation 12
- Purpose of the Investigation 19
- Hypotheses or Key Questions 20

2 SELF-PERCEPTION OF ABILITIES ON THE TELEPHONE RELIABILITY STUDY 24

- Introduction 24
- Subjects 26
- Instrumentation and Procedures 27
- Data Analysis 30
- Results 31
- Discussion 35

3 PILOT VALIDATION OF THE SELF-PERCEPTION OF ABILITIES ON THE TELEPHONE SCALE 40

- Introduction 40
- Methods 42
- Results 55
- Discussion 74

4 DISCUSSION 93

APPENDICES

A OPEN-ENDED QUESTIONNAIRE 102

B PILOT VERSIONS OF SPAT AND SPAT-CP 104
C CONCORDANCE/DISCONCORDANCE MEASURES 110
D FINAL VERSIONS OF THE SPAT AND SPAT-CP 113
E INSTRUCTIONS FOR TELEPHONE CONVERSATION 118
F TELETOPICON FORM 119
G TELETOPICON RAW SCORES 123
H AGREEMENT BETWEEN TELETOPICON RATERS 128
REFERENCES 131
BIOGRAPHICAL SKETCH 141

Abstract of Dissertation Presented to the Graduate School
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A major complaint of hearing aid wearers is the difficulty experienced during telephone communication. Little research, however, exists in telephone therapy for individuals with hearing loss. One reason for this deficiency is the absence of a standardized method for determining telephone abilities. The goal of this project was to develop a standardized self-rating scale, the Self-Perception of Abilities on the Telephone (SPAT) to measure telephone communication strengths and weaknesses of individuals with hearing loss. The rating statements were developed by using the responses to an open-ended questionnaire on telephone use completed by individuals with hearing loss. These rating statements were then compiled to create a 20-item self-rating scale in pilot form. Statistical measures were applied to the results from an administration of the pilot form to 58 individuals with hearing loss to create a shortened, more clinically efficacious tool. The second goal of the project was to validate the abbreviated scale via an interactive telephone exercise. The conversation was rated by two audiologists for overall conversational fluency. The information from both the self-perception tool and the conversation was correlated with the pure tone average, word recognition scores under headphones, word recognition scores using a telephone in a noisy background, and real ear measures using subject preference telephone listening conditions for 47 subjects with hearing loss. Pure tone average and real ear measures did not demonstrate a significant correlation with the SPAT score; however, word recognition scores in both test paradigms did. The average of both conversational raters significantly correlated with the SPAT. Family interaction regarding telephone use was examined by having a communication partner complete a matching rating scale, Self-Perception of Abilities on the Telephone-Communication Partner (SPAT-CP). The SPAT and SPAT-CP scores were found to correlate ($p < .05$). The SPAT-CP did not, however, correlate with the conversational ratings. Discussion centered on forces driving the use of self-rating tools and areas for further research. Proposed research included using the SPAT/SPAT-CP in developing appropriate, efficacious telephone rehabilitation programs.

CHAPTER 1
INTRODUCTION AND REVIEW OF THE LITERATURE

Introduction

Telephone use remains a major problem for individuals with hearing loss. This statement is reiterated time and again by such individuals on questionnaires regarding the disabling effects of hearing loss (Bowe, 1991; Kepler, Terry, & Sweetman, 1992; Lalande, Lambert, & Riverin, 1988; May, Upfold, & Battaglia, 1990; Tyler, Baker, & Armstrong-Bednall, 1983). Successful telephone communication depends upon the speech articulation and receptive/expressive language abilities of the speakers and the auditory mechanism and language processing capabilities of the listeners. Additionally, the quality and proper function of the two telephones and the telephone connection have a direct impact on the telephone users' ability to hear and understand (Erber, 1985; Holmes & Frank, 1984; Holmes, Frank, & Stoker, 1983; Rodriguez, Holmes, DiSarno, & Kaplan, 1993). Requirements largely out of the control of the individual with hearing impairment therefore limit his or her ability to use the telephone. However, with awareness of potential communication problems and subsequent appropriate use of specific strategies to facilitate and repair conversation, the telephone user with a hearing loss can improve telephone communication (Erber, 1985).

A prerequisite for successful training in communication strategies is the need for methods that measure existing skills and tools that measure the efficacy of the treatment. Existing measurement tools, including degree of loss, unaided versus aided speech reception thresholds, and word recognition scores before and after telephone counseling are inadequate for either of the above tasks. The purpose of this investigation is to develop a reliable and valid test to determine the individual's current telephone skills. This measurement tool would assess both the individual's attitudes and his/her significant other's attitudes regarding the individual's telephone abilities. It would also assess the individual's current repertoire of telephone communication strategies through an actual telephone conversation.

This chapter is divided into three main sections. The first section reviews the electroacoustic characteristics of the telephone, current strategies used to aid listeners with hearing loss in telephone communication, and noted difficulties of such listeners with the telephone. The second section reviews current evaluation methodologies in aural rehabilitation including the use of self-rating scales and communication strategies. This section also includes how these methodologies are currently used in relation to telephone communication testing. The final section of this chapter delineates the research hypotheses and purpose of this investigation.

The Telephone

The telephone and related telephone technology are arguably the most important communication related device in mankind's history. Telephones allow us to speak without time delay to almost anyone, almost anywhere in the world. Telephones allow immediate communication and information exchange over vast distances. Despite this importance to our society, few telephone users realize how the telephone network functions. All telephone sets must conform to government specifications for transmission parameters such as frequency response, operating current, distortion, handset noise, and receiver volume (Fike & Friend, 1983). Telephone access issues related to hearing aid compatibility have also recently undergone legislative scrutiny. All corded telephones manufactured or imported for use in the United States had to be hearing aid compatible after July 16, 1989. All cordless telephones had to be hearing aid compatible after August 16, 1991 (Compton, 1991). Exceptions to these regulations included public mobile telephones, private radio telephones, and security access limited telephones. Private home owners were not required to replace incompatible wired telephones.

Guidelines for regulations and standards for wireless and cellular telephones are currently being written as a joint effort between the hearing aid manufacturers association, the wireless telephone manufacturers and related professional and consumer organizations (Compton, 1991; Telecommunication Act, 1996).

The most common wire line based telephone set in use in North America is the Bell system 500 series telephone set (Holmes, 1982; Inglis & Tuffness, 1951). The 500 series uses a model U1 ring armature receiver that has a low mechanical impedance and a high ratio of area to mass resulting in an efficient transducer and a flat frequency response between 200 and 7000 Hz (Holmes, 1982; Mott & Miner, 1951). The transmitter for the 500 series telephone set is a granular carbon-type microphone that varies in output as a function of frequency. Output increases as frequency rises from 250 to 2500 Hz followed by a precipitous drop after 3500 Hz, thus making the transmitter the most important frequency limiting component in the telephone (Holmes, 1982). Due to the lack of uniformity in frequency response, output of the device is difficult to specify. Stoker (1981) noted the average output of a normal telephone conversation is approximately 86 dB SPL at 1000 Hz.

Hearing Aid to Telephone Coupling Strategies

Individuals with hearing loss differ in their ability to use the acoustic information provided by the telephone set. Methods of telephone use range from "normal," i.e., no special devices or amplifiers, to use of a Telephone Communication Device for the Deaf (TDD) (Erber, 1985). Individuals with moderate to moderate-severe hearing losses often need an amplification device coupled either acoustically or magnetically to the telephone to boost the output signal. These devices include amplifier handsets, portable amplifiers, hardwired amplifiers, hearing aids and hearing aid telecoils (Erber, 1985; Holmes, 1982).

Acoustic coupling of the hearing aid to the telephone involves holding the telephone handset next to the microphone of the hearing aid. This type of coupling is often problematic due to "whistling" or acoustic feedback. Sound from the ear canal deflects into the hearing aid's microphone as the proximity of the telephone handset blocks and reflects normal sound leakage (Holmes, 1982).

Telecoil or electromagnetic coupling involves switching off the regular microphone of the hearing aid and turning on a built-in magnetic induction pickup coil. This type of coupling reduces the problem of acoustic feedback; however, distortion from other electromagnetic sources (fluorescent lighting, video terminals) can cause signal distortion. Telecoil frequency responses of a given hearing aid can also vary greatly from the microphone setting frequency response of the same instrument (Sung & Hodson, 1971; Tannahill, 1983). Successful use of all such telephone coupling strategies is dependent on the system's intensity and frequency response and the working knowledge of the device by the user (Erber, 1985; Fikret-Pasa & Garstecki, 1993; Gladstone, 1985; Pichora-Fuller, 1981; Stoker, 1982).

Typical hearing aid users are not well versed in their knowledge or use of the telephone with the hearing aid (Harris, Thomas, & Lamont, 1981; Holmes & Chase, 1985). Poor user performance in part relates to the general lack of interest in telephone amplification by the dispensing audiologist (Schow, Balsara, Smedley, & Whitcomb, 1993). One explanation for the lack of interest in telephone communication among clinicians is the history of a paucity of appropriate telephone amplification technologies (Holmes, 1985; Rodriguez, Meyers, & Holmes, 1991; Terry, Bright, Durian, Kepler, Grim, & Sweetman, 1992) and few established quantitative clinical methodologies for selection and fitting of telecoils and telephone amplifiers (Fikret-Pasa & Garstecki, 1993; Stoker, 1983).

Hearing aids are simply not very compatible with new telephones, and audiologists have been limited in what they could recommend to remedy this problem. In the very recent past, the frequency response and intensity of the telecoil were always predetermined by the manufacturer in all hearing aids. The manufacturer would use a telecoil of a given frequency response and strength based upon the audiometric test results of the patient. If the patient was dissatisfied with the telecoil, little could be done by the audiologist to improve it.

Electromagnetic induction dictates that the telecoil must be held perpendicular to the telephone handset for optimal pickup of the electromagnetic leakage. Maintaining this position during normal conversational situations can be fatiguing or be physically impossible due to the position of the coil in the hearing aid. Telecoils are also susceptible to unwanted electromagnetic interference from fluorescent lights and/or computers, a fact that can render them useless in occupational settings (Compton, 1991). The use of personal telephone amplifiers other than telecoils, although beneficial, requires either extra batteries or hard wiring. Recent research also shows several personal telephone amplifiers may have poorer frequency responses and less amplification than advertised (Fikret-Pasa & Garstecki, 1993).

However, audiologists have the clinical capability to measure telecoil influence using an audiometer-telephone interface (ATI) or a commercially available handset demonstrator as the signal for real ear measurements (Fikret-Pasa & Garstecki, 1993; Grimes & Mueller, 1991; Rodriguez et al., 1993). He or she can then take advantage of the improvements in the technology of hearing aid to telephone compatibility by fitting digital programmable hearing aids (Kuk, 1993; Stypulkowski, 1993). Digital to analog systems allow for in office adjustments in the telecoil circuitry.

Sophisticated telephones will also soon have adjustable frequency responses and internal volume amplifiers to fit the need of the user (Davidson & Noe, 1994; Terry et al., 1992). The audiologist will measure the hearing aid output using a telephone signal as input and make necessary acoustic changes related to telephone use without factory intervention. To make clinically appropriate changes, audiologists require accurate, reliable and clinically feasible methods of measuring telephone communication success.

Aural Rehabilitation and Telephone Use

The arrival of this technology coupled with the population phenomena of "the aging of America" and the legal demands of the Americans with Disabilities Act (ADA) (Bowe, 1991) will increase the demand for aural rehabilitation services. Users of newer, more sophisticated hearing aid systems will need instruction on how to take advantage of environmental and situational specific amplification that now includes telephone amplification.

Research into the actual use of the telephone by the individuals with hearing loss is currently a neglected area in the field of speech and hearing sciences (Erber, 1985). This neglect is most apparent in the scarcity of research in telephone amplification and in the absence of effective ways of measuring telephone communication skills. The lack of research in the area of telephone rehabilitation is not, however, a reflection of the perceived needs of individuals with hearing loss. Tyler, Baker, and Armstrong-Bednall (1983) reviewed the results of an open-ended questionnaire sent to 250 hearing aid candidates and 250 hearing aid users in Great Britain. The average age of the former group was 66.3 years and the latter average age was 68.7 years. Most of the hearing aid wearers (64%) used body aids; however, the authors note the more recent fittings were behind the ear styles. Twenty-one percent in each group noted difficulty communicating over the telephone. Telephone conversation was in the top five list of problematic communication areas for each group. The authors note hearing aids did not appear to help telephone communication; however, they note the high numbers of body aid users and the location of the study may have skewed this observation. Many of the body aids distributed by the National Health Service do not have telecoils and the telephone system in Great Britain at the time of the study was not hearing aid compatible.

Lalande, Lambert, and Riverin (1988) used a questionnaire format to determine the psychosocial disadvantages associated with noise-induced hearing loss. Sixty-five metal product workers and their nearest relatives participated in the study. The workers had an average of 17 years of noise exposure. Noise-induced hearing loss created three separate areas of psychosocial impairment; decreased quality of life at home and work, increased isolation with loss of self-esteem, and decreased ability to use the telephone or participate in leisure activities. The latter category was defined by an inability to hear the telephone ringing and a lack of ability to take accurate telephone messages. The authors stressed the need for worker counseling regarding the use of telephone amplification devices.

Bowe (1991) reported on the results of a survey sent to adults with severe to profound hearing losses. The respondents who tended to be working, college educated adults were asked a variety of questions regarding information access, including telephone use. Fifty-seven percent reported difficulty using the telephone and they were willing to pay up to $15.00 per month to improve their access to telephone communication. A major concern of the group surveyed was an inability to use existing safety systems in their communities, including 911 numbers.

Kepler, Terry and Sweetman (1992) reported survey results garnered from 104 members belonging to a national support group for the hard of hearing, Self Help for the Hard of Hearing (SHHH). Results of this survey suggest a keen interest among the respondents to improve their ability to communicate over the telephone. The authors note 69% of the respondents indicated that their hearing impairment discourages them from using the telephone. Fifty-one percent reported sometimes avoiding using the telephone due to their hearing loss and 75% found hearing over the telephone to be "somewhat" to "extremely difficult." The most difficult areas of telephone use reported were hearing over the telephone in the presence of background noise, low volume of the transmitted signal, poor clarity of the signal, and difficulty acoustically coupling the telephone and the hearing aid. The authors note SHHH members are more sophisticated than the average individual with hearing loss and the actual status of telephone use may be worse than depicted by the survey. They recommend that audiologists be more interactive with the client in choosing the correct telephone amplification method and improve teaching methods for the correct use of the telephone.

To determine telephone listening problems in a more typical population of older adults with hearing loss, a letter in the form of an open-ended questionnaire was mailed to fifty veterans who are patients of the Gainesville Veterans Administration Medical Center Audiology Clinic (GVAMC) (Kaplan, Holmes, & Yanke, 1996) (Appendix A). The 50 veterans were selected to fit the hearing loss criterion of sensorineural hearing impairment no greater than 60 dB HL at 2000 Hz with a pure tone average poorer than 30 dB HL, but not greater than 70 dB HL and the age criterion, 55 to 70 years. The inclusion criteria ensured the use of older subjects with losses severe enough to hinder, but not preclude telephone use. The letter requested the veteran to note if he used the telephone, and any problems he has with the use of the telephone. Of the 50 letters mailed, the post office returned five as undeliverable. Twenty-two of the letters were returned for a response rate of 49%; two were not usable as the veteran was either not competent or deceased. Of the responding veterans, only 10% were satisfied with their ability to use the telephone with their hearing aids, while 20% reported avoiding using the telephone if possible. Twenty-five percent noted they simply could not use the telephone with their hearing aids. The two most common problems associated with telephone use were background noise (30%) and acoustic feedback when coupling the hearing aid with the telephone (45%). Only 15% of the responding veterans mentioned the use of communication strategies to improve understanding conversation over the telephone. Clearly, telephone use is problematic for individuals with hearing loss.

Current Methods of Evaluation in Aural Rehabilitation

An individual's self-perception of skills or self-rating of disability has been established as a clinically relevant and accurate method of identifying areas in need of remediation (McCarthy, Montgomery, & Mueller, 1990). Early efforts in this area began with The Hearing Handicap Scale developed by High, Fairbanks and Glorig (1964). The authors noted the need for an efficient and accurate method of measuring hearing handicap that they define as "any disadvantage in the activities of everyday living that derives from hearing impairment,(p.215)." This need was especially great when treating individuals with moderate hearing impairments as "the inconvenience, expense, and risk associated with some of the more vigorous remedies may or may not be balanced by a worthwhile reduction in handicap, (p.215)."

Since the development of the Hearing Handicap Scale (High, Fairbanks, & Glorig, 1964), a variety of self-report scales for aural rehabilitation have been developed (Alpiner, Chevrette, Glascoe, Metz, & Olsen, 1974; Demorest & Erdman, 1987; Giolas, Owens, Lamb, & Schubert, 1979; Kaplan, Bally, & Brandt, 1991; McCarthy & Alpiner, 1980; Newman & Weinstein, 1986; Noble & Atherly, 1970; Speaks, Jerger, & Trammell, 1970). These scales address perceived level of disability, attitudes of patient and family toward hearing loss, coping skills, communication performance in different settings, hearing aid performance and hearing aid use (Hutton, 1991; Schow, Balsara, Smedley, & Whitcomb, 1993). According to Erber (1988), hearing handicap scales should reveal the client's personal attitudes, general psycho-social and vocational adjustment, and indicate areas where the client identifies the hearing impairment as a handicap. The scales should be designed to yield diagnostic data to guide communication therapy.

Self-rating scales such as the Hearing Handicap for the Elderly (Ventry & Weinstein, 1982) are enjoying unprecedented use in aural rehabilitation (McCarthy, Montgomery, & Mueller, 1990; Schow, Balsara, Smedley, & Whitcomb, 1993) especially in the area of hearing aid fitting outcomes and user satisfaction. The scales are completed by the client as in the case of the Hearing Handicap Scale (High, Fairbanks, & Glorig, 1964), the client and a family member as when administering the McCarthy-Alpiner Scale of Hearing Handicap (M-A Scale, 1980) or by a resident with hearing loss and a caregiver as with the Nursing Home Hearing Handicap Index (Schow & Nerbonne, 1977). In the latter two examples, comparisons can be made between self-perception of abilities and the perceptions of individuals close to the person with the hearing impairment. Again, such comparisons become purposeful in designing appropriate individualized therapy sessions and can serve as reliability/validity measures for the individual's self-assessment of communication skill (Chmiel & Jerger, 1993; Newman & Weinstein, 1986).

These scales are usually given in a paper/pencil format. The individual reads a statement regarding his or her hearing impairment or its effects in a given conversational or listening situation. The respondent then marks the descriptor that best fits his or her perception of the hearing loss or of his or her ability to deal with the listening situation. The Hearing Problem Inventory (Hutton, 1980) uses a five-point scale with descriptors ranging from "Almost Always" to "Unnecessary." Descriptors, however, vary with the question and are not given numeric scaling. By contrast, the Denver Scale of Communication Function (Alpiner et al., 1974) only uses "agree" and "disagree" as top and bottom descriptors on a seven-point scale to develop a hearing handicap profile in four areas of therapy interest, namely family, self, social-vocational, and communication. Alpiner's group then developed the Quantified Denver Scale (Alpiner et al., 1974) which uses "strongly disagree" to "strongly agree" with a five-point numeric scale.

Although these self-perception of handicap measurement tools are quite useful, one specifically designed for telephone communication does not exist. Among existing hearing disability questionnaires, i.e., the Hearing Handicap Scale (High, Fairbanks, & Glorig, 1964), the Hearing Handicap for the Elderly (Ventry & Weinstein, 1982), The Social Hearing Handicap Index (Ewertsen & Birk-Nielsen, 1973) and The Hearing Measurement Scale (Noble & Atherly, 1970), telephone use is either not addressed or only examined in a cursory manner. For example, the Social Hearing Handicap Index asks one question regarding telephone ability, "Is it difficult for you to follow a telephone conversation?" The Hearing Handicap Scale asks essentially the same question, "Can you carry on a telephone conversation without difficulty?" and also adds "Can you hear the telephone ring when you are in the room where it is located?"

In addition to individual self-assessment, perception of family members is also being investigated as an adjunct for the aural rehabilitation process (Hetu, Jones, & Getty, 1993). The negative effects that an individual's hearing impairment can have on a family, a spouse and/or a significant other have been reviewed in the audiologic literature in some detail (Oyer & Oyer, 1985; Pedley, 1989; Wood & Kyle, 1983) and in the literature of other related disciplines (Beattie, 1981; Oyer & Paolucci, 1970). Study methodologies including individual questionnaires, joint questionnaires, and interviews suggest the significant other suffers from the excessive effort needed to converse with partner who has a hearing loss. Problems noted by the normal hearing partner include stress, anxiety, irritation, restrictions in social interactions, loss of self-image, and feelings of isolation (Hetu & Getty, 1991; Hetu, Jones, & Getty, 1993).

The audiologist is viewed as the logical counselor for problems related directly to the hearing impairment and thus serves as an important support provider for both members of an intimate relationship (Beattie, 1981; Hetu, Jones, & Getty, 1993). One method of tapping into the informational and social support needs of a couple is the use of questionnaires given jointly or individually. Such questionnaires regarding the disabling effects of the hearing loss can then serve as springboards for discussion and counseling sessions.

The current philosophy in aural rehabilitation is to train individuals to use communication strategies that ease conversation (DeFilippo & Scott, 1978; Kaplan, Bally, & Garretson, 1986; Tye-Murray, Knutson, & Lemke, 1993). While the effective use of communication strategies demands the utilization of specific tasks such as asking for repetition or requesting the key word of a sentence, communication strategies also require personal awareness. The latter includes training in use of space to enhance acoustics and lessons in personal assertiveness (Tye-Murray, Purdy, & Woodworth, 1992). The measurement of successful strategy use includes paradigms for words per minute and rating scales (Owens & Telleen, 1981).

Current research efforts in this area include finding out if individuals with hearing impairment use communication strategies and which strategies are most effective (Gagne & Wyllie, 1989; Tye-Murray, 1991; Tye-Murray, Purdy, & Woodworth, 1992; Tye-Murray, Purdy, Woodworth, & Tyler, 1990). Tye-Murray, Purdy and Woodworth (1992) surveyed 212 members of the organization, Self-Help for Hard of Hearing People (SHHH) regarding their use of strategies. This group of relatively sophisticated individuals noted repetition was the strategy of choice despite other research suggesting repetition is the least effective strategy for repairing communication breakdown (Kelsay, Fryauf-Bertschy, & Tye-Murray, 1990). Tye-Murray (1991) notes "real world performance is difficult to assess objectively, (p. 927.)." She discusses the need to develop real conversation situations for pre- and posttherapy measures, the need to develop tools to quantify communication behaviors, and the importance of being unobtrusive in recording and measuring these behaviors.

TOPICON (Erber, 1988) is another method for rating conversational fluency in aural rehabilitation clients that attempts to address efficacy concerns. TOPICON can also be modified to use for conversation sampling and therapy practice. This involves each communicator (therapist and client) noting topics of conversational interest and then picking a topic to engage conversation. The therapist and client carry out the brief conversation while the therapist also serves as monitor. The session ends by discussing the success or failure of the exercise. TOPICON allows for client involvement and participation in selecting topics and monitoring success. This strategy also allows the clinician freedom to manipulate the difficulty of the listening environment.

Success of the TOPICON conversation is measured by an overall conversational fluency rating and by rating fifteen pragmatic features (Erber, 1988). Overall fluency is rated on a five-step scale with "low" to "high" as the descriptors. The fifteen pragmatic features are presupposition, receptive abilities, expressive abilities, motivation/attention, turn taking, specificity/accuracy, new versus old information, nonverbal communication, topic maintenance, cooperation, timesharing, verification, independent repair, metacommunication (language awareness), and other. The pragmatic features are rated in the same manner as overall fluency. Results of the rating can be used to plan future therapy sessions.

Despite the current interest in communication strategies, there has been little research into effective methods to evaluate the hearing aid user in communication repair and facilitation strategies while on the telephone (Erber, 1985). The evaluation and training programs that exist have been primarily focused on young adults with severe to profound hearing impairments, rather than the more typical individuals with moderate to severe sensorineural hearing impairments (Castle, 1977; 1981). Castle's work consists of training adults with severe to profound hearing losses to recognize the sounds of the telephone, including the dial tone, busy signal, and ringer. Her emphasis is on one-way communication for emergency purposes and on very structured conversations with significant others who are aware of the severity of the hearing loss of the individual. A person with a moderate to severe hearing loss would not need or benefit from such training.

Purpose of the Investigation

Accompanying the need for training is the need for methods to measure existing skills and training efficacy.

This study hypothesizes current measurement tools, including degree of loss, unaided versus aided and pre and post hearing aid fitting word recognition scores, are inadequate for fitting telephone amplification devices and are also inadequate for measuring improvement after therapy. The study proposes a TOPICON based rating of a simulated telephone used with a self-perception and significant other perception of telephone ability scale is more realistic and multidimensional. The simulated conversation rating and the self-perception scales will therefore provide more clinically relevant information from which to measure telephone amplification devices and from which to develop telephone rehabilitation instructional plans and counseling session formats.

Hypotheses or Key Questions

The goal of this project is to develop a tool to measure the telephone communication abilities of individuals with moderate to severe hearing losses.

Specific aim (1). Develop a self-rating scale for individuals with hearing loss regarding their patterns and strategies of telephone use, Self Perception of Abilities on the Telephone (SPAT). The SPAT will include separate rating scales for both the client and his or her communication partner/significant other to measure communication fluency while using the telephone. The following research questions will be addressed:

1. Does degree of hearing loss as measured by pure tone average (500 Hz, 1000 Hz, & 2000 Hz) correlate with self-rating of telephone communication ability?
2. Does word recognition score as measured by percentage correct on the Northwestern University #6 word lists under headphones correlate with self-rating of telephone communication ability?
3. Does word recognition score as measured by percentage correct on the Northwestern University #6 word lists using a telephone handset via an Audiometer Telephone Interface (ATI) in a noisy environment correlate with self-rating of telephone communication ability?
4. Does frequency/intensity response curve of the preferred telephone listening strategy as measured by real ear probe microphone instrumentation correlate with self-rating of telephone communication ability?
5. Does the subject's self-perception of impairment level as measured by SPAT correlate

with the SPAT rating given by his or her communication partner/significant other?

Specific aim (2). Develop a simulated interactive telephone conversation to evaluate current communication strategies and overall conversational fluency during telephone use. This will consist of a scripted series of questions regarding a specific task, i.e., ordering an airline ticket over the telephone in a role play with the audiologist. The scripted tasks will be completed using standard audiometric equipment coupled to an audiometer-telephone-interface (ATI). Each exercise will be audiotaped for later rating. The following research questions will be addressed:

1. Does degree of hearing loss as measured by pure tone average (500 Hz, 1000 Hz, & 2000 Hz) correlate with score on simulated telephone task?
2. Does word recognition score as measured by percentage correct on the Northwestern University #6 word lists under headphones correlate with score on simulated telephone exercise?
3. Does word recognition score as measured by percentage correct on the Northwestern University #6 word lists using a telephone handset via an audiometer-telephone interface

unit in a noisy environment correlate with score on a simulated exercise?

4. Does frequency/intensity response curve of the preferred telephone listening strategy as measured by real ear probe microphone instrumentation correlate with score on a simulated exercise?

5. Does conversational fluency as measured by a simulated telephone exercise correlate with the SPAT score?

6. Does conversational fluency as measured by a simulated telephone exercise correlate with the SPAT score given by the communication partner/significant other?

CHAPTER 2
SELF-PERCEPTION OF ABILITIES ON THE TELEPHONE RELIABILITY STUDY

Introduction

This chapter details the development and subsequent reliability check of the Self-Perception of Abilities on the Telephone Pilot Version (SPAT-PV) and the Self-Perception of Abilities on the Telephone-Communication Partner Pilot Version (SPAT-CP-PV). Initial considerations in developing a self-rating scale include defining construct, test utilization, and target population. Standardization issues also need to be addressed, including method of administration, method of scoring, level of measurement, normative data, and determination of reliability (Demorest & DeHaven, 1993).

The purpose or construct definition of the pilot version and the final version of the SPAT is to permit individuals with hearing loss to self-measure their ability to communicate over the telephone while the SPAT-CP-PV and SPAT-CP are designed to allow a communication partner to rate the telephone skills of the individual with the hearing loss. Uses of the final versions of the SPAT and SPAT-CP include pre and post measures of hearing aid or assistive listening device fittings, counseling strategies, and aural rehabilitation therapy programs.

The pilot and final versions of the SPAT are designed for adults with hearing impairments significant enough to impair their ability to communicate over the telephone, but not so severe as to preclude their use of the telephone via audition. The SPAT-CP-PV and SPAT-CP target a "significant other" or telephone communication partner of the individual with hearing loss. The communication partner must be able to rate the individual with hearing loss's ability to communicate over the telephone.

The pilot versions of the SPAT and SPAT-CP are designed to be administered in a pencil/paper format while under supervision to avoid collusion. The pilot versions of the SPAT and SPAT-CP are not scored as their purpose is to test statements for inclusion into a shortened final version which will be scored.

Reliability is integral to test development as it is an essential component of validity (Nunnaly, 1978). Internal reliability or item consistency in the form of a Cronbach coefficient alpha will be established to determine the level of internal consistency of each test form. This information will then be used in the development of the final versions of the SPAT and SPAT-CP.

Subjects

Fifty-eight couples consisting of subjects with hearing loss and a communication partner completed the pilot questionnaire. Subjects were solicited from the clinic population at the University of Florida Communicative Disorders Clinic, the Gainesville Veterans Administration Audiology Clinic, clinical patients in a private otolaryngology practice in Gainesville, and from private audiology and otology practices of associates of the author. Subject selection was based on the hearing loss criterion of a sensorineural hearing impairment no greater than 60 dB HL at 2000 Hz with a pure tone average poorer than 30 dB HL, but not be greater than 70 dB HL. Communication partner is defined as an individual who could rate the subject's performance on the telephone. Subject confidentiality for the reliability study was maintained by assigning a number to all participants.

Subjects ranged in age from 18 years 5 months to 94 years. Shands Communicative Disorders Clinic and the Audiology Department at the Gainesville Veterans Administration Medical Center accounted for 22.4% or 13 subject/partner pairs each. Two subject pairs or 3.4% were from the private otolaryngology clinic and 30 subject pairs or 51.7% were from the other above-mentioned sources.

Most of the communication pairs were married (n= 49, or 84.6%). Other relationships included a parent of the individual with hearing loss (n= 2, or 3.4%), a child of the individual(n=2, or 3.4%), a friend or neighbor (n=2, or 3.4%), a relative other than parent, child, or sibling (n=2, or 3.4%), and a sibling (n=1 or 1.9%). Figure 2.1 is a graph depicting the relationship between the subjects and their communication partners.

Instrumentation and Procedures

The pilot study of the reliability of the SPAT and SPAT-CP is based upon the work of Weinstein, Spitzer, and Ventry (1986) and Newman, Weinstein, Jacobson, and Hug (1991). A pool of 20 statements regarding telephone use were developed from open-ended questionnaires given to veterans with hearing loss in North Central Florida (Kaplan, Holmes, & Yanke, 1996). Specific problematic areas expressed by the veterans and therefore addressed in the pilot questionnaire included preferred telephone amplification method, management of acoustic feedback, use of communication strategies to facilitate telephone communication, degree of difficulty using different types of telephones, and use of strategies to manage listening environments.

The subjects and their communication partners were monitored while completing the pencil/paper format rating scale to prohibit discussion of their answers. Each version of the questionnaire included 20 statements regarding telephone use. The SPAT-PV was written in the first person or

"I" format and the SPAT-CP-PV was written from the communication partner's viewpoint, "My partner." The 20 statements consisted of 16 statement pairs made up of 8 statements about telephone use with a negative focus or slant, and 8 statements regarding the same topic with a positive focus. Four other item pairs consisted of statements which were neither negative nor positive in focus. Random draw determined the order of the sentences.

The 20 closed-ended items are followed by an ordered choice rating scale of 1(strongly agree), 2 (agree), 3 (disagree), and 4(strongly disagree). Participants were instructed to rate every statement to the best of their ability. Options such as "neutral" or "no opinion" were not included to force a choice for a descriptive rating. Refer to Appendix B for original pilot versions.

The positive question set consisted of the following questions:

1. I never confuse things when listening over the telephone.
4. I do not have to ask people to repeat when talking over the telephone.
6. I have no trouble understanding telephone conversations if the room is noisy.
7. I do not mind using the telephone.
11. I seldom ask someone else to talk for me on the telephone.

14. I do not have trouble understanding friends over the telephone.

16. I do not have trouble understanding strange voices over the telephone.

19. In general I hear well over the telephone.

The negative question set consisted of the following:

2. I usually have problems hearing over the telephone.

8. I often ask someone else to call for me.

9. I do not like to use the telephone.

12. I often have to ask people to repeat themselves during telephone conversations.

13. I often misunderstand conversations over the telephone.

17. I have difficulty understanding telephone conversations if the room is noisy.

18. My friends can be hard to understand over the telephone.

20. I have difficulty understanding strangers over the telephone.

The four unrelated statements consisted of the following:

3. I can understand men's voices better than women's voices over the telephone.

5. I always tell people I have a hearing loss when using the telephone.

10. I never tell people I have a hearing loss when using the telephone.

15. I can understand women's voices better than men's voices over the telephone.

Data Analysis

A data code book was developed for the SPAT-PV and the SPAT-CP-PV. Data was entered into a proprietary database computer program (Paradox for Windows version 1.0, Borland International, Scotts Valley, CA, 1992) by the principal investigator. Data analysis was conducted using a proprietary statistical program Statistical Analysis Software (SAS)(SAS Institute, Cary, NC). Specific analysis consisted of frequency measures reported in percentages for identifying questions, a coefficient alpha and concordance/discordance measures on each positive/negative statement pairing. The reliability measures and concordance/discordance measures were then used to determine if the SPAT-PV and SPAT-CP-PV could be shortened.

Reliability of the SPAT-PV and SPAT-CP-PV was determined using a coefficient alpha providing a rating of inter-item consistency (Cronbach, 1951; Kaiser & Michael, 1975; Novick & Lewis, 1967). The coefficient alpha was deemed an appropriate measure of this task as both rating forms require the subject to make a choice among several descriptors rather than a yes/no response. This rating was also appropriate as the SPAT and SPAT-CP are measures of the relatively homogeneous skill of ability to communicate over the telephone. The coefficient alpha also permitted a reliability score based upon one test administration, thereby avoiding the biasing effects and technical problems inherent in repeated administrations methodology.

Disconcordance/concordance, a measure of the tendency for participants to answer a set of questions in a similar or dissimilar manner, was then calculated for each of the sentence pairs. If concordance values are greater than discordance values then the rating tended to be similar. Conversely, if discordance values are greater than concordance values, the rating would not be viewed as similar. Higher disconcordance values between oppositely slanted sentences would therefore suggest the subject rated the pair members consistently despite the slant of the statements.

Results

Subjects and their communication partners were asked how the individual with hearing loss most often uses the telephone. Most of the subjects reported listening over the telephone without using any form of amplification. Two subjects did not answer the question. Thirty-seven of the remaining 56 subjects (66.1%) used the telephone alone, 9 subjects (16.1%) used the telephone and their hearing aid on microphone setting, 6 subjects (10.7%) used a telephone amplifier, 2 subjects (3.6%) used the telephone and their hearing aid set on telecoil setting, and 2 subjects (3.6%) used an amplified handset alone.

The communication partners' responses to the same question of how the individual with hearing loss most often uses the telephone differed only slightly, however the pattern of predominantly using the telephone alone held. One communication partner did not answer the question. Thirty-seven partners (64.9%) noted the individual used the telephone alone, 7 (12.3%)noted the individual used the telephone with the hearing aid set on microphone, 8 (14%) noted using a telephone amplifier, 2 (3.5%)noted the individual used the hearing aid on telecoil setting, and 3 (5.3%) noted the individual most often used an amplified handset. Telephone use strategies delineated by respondent type are depicted in Figure 2.2.

Years of reported hearing aid use by the individuals with hearing loss ranged from "never used a hearing aid" to 54 years of use. Nineteen subjects (34.5%) had never worn a hearing aid or were currently purchasing a hearing aid(s). Of subjects reporting hearing aid use, the median was 5 years. Three of the subjects did not answer the question.

Hours of hearing aid use per day varied from twenty-one subjects noting they "do not wear the hearing aid on a daily basis" to one subject wearing the hearing aid 19 hours per day. Nineteen of the twenty-one subjects who do not wear their hearing aids were either nonusers or were in the process of obtaining a hearing aid(s). The average daily hearing aid use for the remaining subjects was 11.3 hours per day. Four subjects did not answer the question.

The individuals noted use of the telephone ranged from less than once per day to 99 calls per day as reported by a telephone receptionist. Twenty-one subjects (37.5%) noted talking on the phone one or less than 1 time per day. Median number of times talking on the telephone per day was 3 times. Two subjects did not answer the question.

Subjects and their communication partners were asked if the communication partner had a hearing loss. Responses were similar with 14 subjects (24.1%) reporting the communication partner to also have a hearing loss, 37 (63.8%) reporting the partner to have normal hearing, and 7 (12.1%) reporting they did not know. Fifteen (25.9%) of the communication partners reported a hearing loss, 35 (60.3%) reported normal hearing, and 8 (13.8%) were not sure if they had a hearing loss or not. Hearing loss status of the communication partner delineated by respondent type is depicted in Figure 2.3.

The Cronbach Coefficient Alpha for the positive slant rating statements on the scale for individuals with hearing loss was 0.76 (raw variables) and .77 (standardized variables). The alpha was .84(raw variables) and .84 (standardized variables) for the communication partners' ratings. The high positive correlation values suggest high internal reliability within the positive slant questions for both forms.

The Cronbach Coefficient Alpha for the negative slant rating statements for the individuals with hearing loss were .85 (raw variables) and .85 (standardized variables). The communication partners' negative slant correlations were .89 (raw variables) and .89 (standardized variables). The high positive correlations suggest high internal reliability within the negative slant questions for both forms.

The Cronbach Coefficient Alphas for the unrelated questions using the data from the subjects were -.51 (raw variables) and -.40 (standardized variables). The alphas for the communication partners' data on the unrelated questions were -.31 (raw variables) and -.13 (standardized variables). The low correlation values were expected and suggest poor internal consistency among these rating statements.

Data related to the concordance/discordance measures can be found in Appendix C. Nine of the 10 statement pairs were found to have higher discordance as compared to concordance values for both the SPAT-PV and the SPAT-CP-PV. This would suggest subjects rated the statements consistently despite the slant of the question. Results for the statement pair related to understanding women versus men over the telephone for communication partners found a higher concordance value than disconcordance value. This does not suggest consistency in response between the pair and would suggest the paired statements do not work as true opposites.

Discussion

The benefits of self-assessment scales in aural rehabilitation therapy have been described in depth (Giolas, 1990; McCarthy, 1994), however these scales continue to be under used (Erdman, 1993). One potential reason for this lack of use may be the perception by audiologists that such scales are cumbersome and too time consuming. Existing scales of considerable length have been shortened to ease these concerns with varying success (Demorest & DeHaven, 1993). The purpose of the pilot versions of the SPAT and SPAT-CP was therefore not only to define the test construct and population, but to develop a usable clinical instrument. To this end, the pilot versions were shortened.

The final versions of the SPAT and SPAT-CP can be found in Appendix D. Questions 13, 19, 12, 6, 9, 11, 14, and 16 were selected based upon wording which avoided double negatives, use of absolutes, i.e., never and always, and improved ease of reading (Dillman, 1978; Smith & Glass, 1987). Questions 3 and 15 which dealt with ease of understanding men versus women were both maintained as they were not opposites and have face validity for rehabilitative counseling. Questions 5 and 10 dealing with revealing the hearing loss to the caller were deleted as both versions used absolutes.

Based upon pilot subject suggestions, the SPAT and SPAT-CP were also revised into a multiple choice format for information related to hearing aid use history and personal history. The statements were also renumbered.

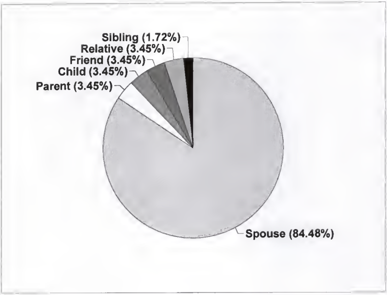

Figure 2.1. Subject/communication partner relationships, n=58.

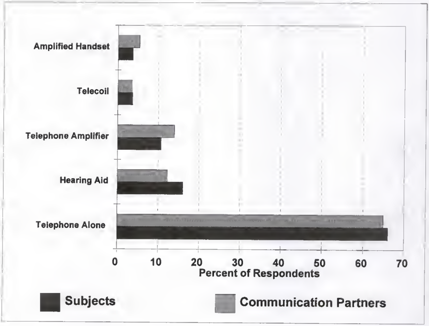

Figure 2.2 Reported telephone coupling strategies. subject n=56, communication partner n=57.

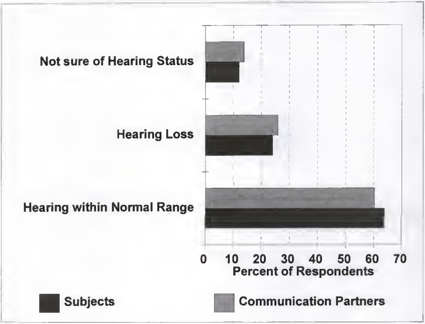

Figure 2.3 Communication partner hearing loss status, n=58 subject/communication partner couples.

CHAPTER 3
PILOT VALIDATION OF THE SELF-PERCEPTION OF ABILITIES ON THE TELEPHONE SCALE

Introduction

The definition of validity has evolved from an emphasis on the appropriateness and usefulness of a given test to the appropriateness, usefulness, and meaning of the inferences test users make when interpreting the score (Demorest & DeHaven, 1993; Smith & Glass, 1987). Self-assessment scale validity is based upon the initial idea or thought complex underlying the scale referred to as construct validity. Based upon the restrictions of construct validity on the scale, the inferences that can be garnered from the scale are limited to the initial construct. In the case of the SPAT, the original proposed construct is the ability of both individuals with hearing impairments and their communication partners to rate the telephone communication performance of the former.

Construct validity can be evidenced by the asking of four questions about the scale (Smith & Glass, 1987). These questions for the SPAT and SPAT-CP are as follows:

1. Is there logical consistency between the content of the test items, in this case the SPAT and SPAT-CP scale statements, and the definition of the construct, i.e. ability to self-measure telephone communication performance?
2. Has an empirical connection been established between the performance on the chosen indicator (the SPAT and SPAT-CP) and some other indicator that purports to measure the same construct, in this example, word recognition scores under headphones and word recognition over the telephone?
3. Has an empirical connection been established between the chosen indicator (SPAT and SPAT-CP) and other indicators of the same construct (independent rating of telephone communication performance) that use different measurement methods? In this case, the rating is derived from scoring actual conversational ability of the subject on the telephone as measured by audiologists who specialize in aural rehabilitation.
4. Have successful efforts been made to establish that the indicator of a construct (SPAT and SPAT-CP) score does not correlate with indicators of other constructs that are theoretically unrelated to the first?

The answers to these questions regarding validity become part of the evolution of the scale developed over time through data collection with the goal of creating an integrated body of knowledge about the test (Demorest & DeHaven, 1993). This chapter therefore describes the initial study in the process of creating the necessary body of information to validate the SPAT and SPAT-CP. A description of subjects, their communication partners, and patterns of hearing aid and telephone use are included. The chapter also delineates the initial validation task including pilot work completed, equipment utilized, validation protocol, rating paradigm, scoring methods and results of the validation study.

Methods

Subjects

Forty-seven individuals with hearing loss served as subjects. Initial selection of the subjects was based on chart review with the criterion of a sensorineural hearing impairment no greater than 60 dB HL at 2000 Hz with a pure tone average poorer than 30 dBHL, but not greater than 70 dB HL in the ear used for the telephone. The study was limited to the "young old" by using an age restriction of 55-72 years of age (Humes, 1996). Each subject had to also have a communication partner or "significant other" capable of rating the subject's performance on the telephone. Subject confidentiality for the validation portion of the study was maintained by assigning a number to all participants.

Thirty-three of the subjects with hearing loss were male and 14 were female. Nine of the communication partners were male and 38 were female. The predominate relationship between the pair was marriage with 31 of the communication partners identified by the subject with hearing loss as a spouse, 8 as children, and 8 as friends. Further breakdown of couple relationships by gender can be found in Tables 3.1 and 3.2.

Table 3.1 Subject Partner Relationships by Gender

	Male Subjects	Female Subjects	Total
Male Partners	3	6	9
Female Partners	30	8	38
Total	33	14	47

Table 3.2 Subject Partner Relationships by Gender and Partner Role

Gender of Subject	Spouse	Child	Friend	Total
Male	26	4	3	33
Female	5	4	5	14
Total	31	8	8	47

Subjects with hearing loss ranged in age from 55 years 1 month to 71 years 7 months with an average age of 65 years. Males were slightly older than females with average ages of 65 years 1 month and 64 years 10 months respectively. Communication partners ranged in age from 24 years 8 months to 77 years 6 months with an average age of 57 years 10 months.

Instrumentation

All subjects had an audiological evaluation completed including standard pure tone air and bone conduction testing, speech reception thresholds, and word recognition testing. Testing was completed by a licensed audiologist using a diagnostic audiometer (Madsen Midimate 602) under headphones (TDH 39P) in a double walled test chamber (IAC #102557) suitable for ears uncovered testing (American National Standards Institute [ANSI] S3.1-1991). Speech testing including speech reception thresholds and word recognition were completed using a compact disc player (JVC XLVII2) routed through the audiometer. Otoscopic checks were performed on all subjects prior to testing.

Subjects' hearing aids were checked electroacoustically on their microphone settings using procedures based on ANSI S3.22-1987. Electroacoustic measures were taken in order to determine the gain, output, and frequency responses of the hearing aids in microphone setting. Hearing aids were tested at use settings.

Telecoil strength was also tested electroacoustically at use settings as delineated by ANSI S3.22 1987 for all instruments equipped with telecoils. Telecoil measurements consisted of the standard specified test at 1000 Hz and a frequency response taken at the maximum output placement with 90 dB SPL input. Electroacoustic test equipment consisted of a hearing aid test box, acoustic computer, and telecoil test board (Fonix 5500Z Hearing Aid Test Set). Hearing aid test equipment was calibrated per manufacturer directions daily and output levels were measured and compared to a calibrated piston rod every five subjects.

The following hearing aid response measures were made on each hearing aid set to use rather than full-on parameters:

1. Maximum Saturation Sound Pressure Level (SSPL 90)
2. Saturation Sound Pressure Level (SSPL 90) Curve, note peak frequency
3. Average Full on Gain
4. Average Full on Gain Curve
5. Total Harmonic Distortion (500 Hz, 800 Hz, 1600 Hz)
6. Telecoil Response at 1000 Hz

Word recognition testing in quiet and noise and the simulated telephone conversation was completed using an Audiometer-Telephone-Interface (ATI) routed through the audiometer (Madsen Midimate 602). The ATI acted as an interface between an audiometer and telephone handset serving to modify the audiometer output by imposing the average characteristics of the telephone including amplification, frequency and line noise (Stoker, 1983). Thus, the speech input (compact disc recording or live voice) was directed to the audiometer, routed through the ATI, and then played through a telephone handset for testing telephone listening ability. The purpose of the ATI is to as realistically as possible simulate telephone frequency response and line noise while maintaining a calibrated intensity. The intensity of the ATI was measured by a sound level meter (Quest 215 Sound Level Meter, ANSI S1.4-1983 Type 2) every 5 subjects. The ATI intensity level was maintained at 86 dB SPL at 1000 Hz. The subject was requested to use the ATI as he or she would normally listen to the telephone, i.e. hearing aid with telecoil, hearing aid acoustically coupled, telephone handset amplifier or no form of amplification for telephone testing paradigms.

A tape of noise (cafeteria babble) was presented to a speaker three feet behind the subject's head via a tape recorder (Marantz Model PMP 220). The tape was calibrated with a 1000 Hz calibration tone and output levels were monitored by a sound level measurements taken at the level of a typical subject's head.

Real ear measures of the individual's preferred hearing aid to telephone coupling strategy were made in order to determine spectral frequency response, frequency response range and intensity of the individual's choice of telephone listening paradigm (Fikret-Pasa & Garstecki, 1993; Grimes & Mueller, 1991; Rodriguez et al., 1993). Real ear measures were taken utilizing a probe microphone system (Biologic Navigator Electrodiagnostic Testing System). A broadband signal was routed through the Audiometer Telephone Interface Unit (ATI) and delivered to the telephone handset (500 Series) with a U-1 receiver. The broadband signal was presented at 86 dB SPL at 1000 Hz, the average intensity of normal telephone conversation (Stoker, 1982; 1983). Telephone intensity measures were obtained with a sound level meter (Quest 215 Sound Level Meter, ANSI S1.4-1983, Type 2).

All equipment was initially calibrated to meet the standards of the American National Standards Institute (ANSI S3.6-1989; ANSI S3.1- 1991). Complete calibration measures were made after every five subjects. Daily listening checks were performed throughout the experiment.

Speech Stimuli

Speech reception thresholds (SRT) measured in decibels hearing level were obtained using the American Speech-Language-Hearing Association (ASHA) guidelines (ASHA, 1988) with a compact disc presentation of the Central Institute for the Deaf Auditory Test W-1 spondee words (Auditory Research Laboratory, Veterans Administration, 1991; Hirsh, Davis, Silverman, Reynolds, Eldert, & Benson, 1952) under headphones (TDH39). Word recognition scores measured in percentage correct were obtained using a compact disc presentation of the Northwestern University Auditory Test No. 6 (NU-6) (Auditory Research Laboratory, Veterans Administration, 1991; Tillman & Carhart, 1966). Each subject was given a full word list (50 words) presented at either +40 dB sensation level of their SRT or at Most Comfortable Listening Level (MCL) when the former exceeded the subject's Uncomfortable Listening Level (UCL). Speech reception thresholds and word recognition scores were obtained both routed through the audiometer under headphones and through the audiometer via the ATI telephone handset.

Procedure

All subjects and their communication partners completed the self-rating scale for telephone use, Self-Perception of Abilities on the Telephone (SPAT) or the Self-Perception of Abilities on the Telephone Communication Partner version (SPAT-CP). Please refer to Appendix D for a copy of both forms. The SPAT and SPAT-CP were given in person with a 1(strongly agree) to 5(strongly disagree) rating scale system. Questions regarding hearing aid use were also addressed on the SPAT and SPAT-CP. The following was the experimental schedule for the subjects and their communication partners.

Completion of the SPAT and SPAT-CP. Twenty-three of the communication partners completed the SPAT-CP by mail while 24 communication partners attended the testing session. The former were directed by the investigator in writing to complete the form independent of the subject. The latter were monitored by the investigator to prevent collusion in completing the rating forms. Subjects were asked to describe how he or she most successfully uses the telephone. The latter information was then utilized as the model for all further testing with the ATI and telephone handset. Subjects were also questioned as to why they use their particular telephone coupling strategy.

Otoscopic check. An otoscopic check was performed on all subjects. Subjects with cerumen impaction were referred to their personal audiologist for management and no further testing was completed until cerumen management/removal had occurred.

Hearing evaluation. Subjects were given a complete hearing evaluation, including pure tone air and bone conduction testing, speech reception thresholds, and word recognition scores under headphones. Word recognition testing under headphones was completed at +40dB SL of the SRT or at patient's most comfortable listening level (MCL) if the former exceeded the patient's tolerance levels. Subjects were initially presented with the word recognition test at +40 dB sensation level of their SRT. The subject was then asked if the level was uncomfortably loud. If the subject noted the presentation level exceeded their uncomfortable listening level, testing was stopped. The subject was then presented with a compact disc presentation of continuous discourse (Auditory Research Laboratory, Veterans Administration, 1991) in order to establish MCL using a forced choice paradigm (Skinner, 1988). An air conduction pure tone test was also completed on communication partners who consented.

Electroacoustic check. Electroacoustic checks of all hearing aids were conducted as described in the Instrumentation section. Malfunctioning hearing aids were reported to the subject and a referral for repair was made to their personal audiologist. Malfunctioning hearing aids only prevented continued participation in the study if the hearing aid was used during telephone listening.

Word recognition testing. Word recognition testing was completed using the ATI in a noisy background (cafeteria babble). The subject used the amplified telephone handset of the ATI as he or she would normally listen to the telephone. A compact disc presentation of the NU-6 word lists (50 word list) was routed via the audiometer through the ATI at 86 dB SPL at 1000 Hz, the level of normal telephone output. Cafeteria babble was presented by audiotape via a speaker three feet behind the subject at 65 dB SPL in order to simulate normal levels of background noise during telephone conversation (Seacord, 1940). Output of the ATI was monitored through the use of a calibration tone (1000 Hz pure tone) on the compact disc played through the compact disc player to the audiometer and the ATI measured with a NBS 9A acoustic coupler attached to the sound level meter. Noise levels were monitored with a sound level meter placed at the level of the typical subject's head.

Simulated telephone conversation. Subjects then participated in a simulated telephone conversation using the

ATI with a trained listener (the principal investigator) in which they were given a series of questions/tasks to complete. Specifically, the subject was asked to book airline reservations over the telephone. The subjects were given an instruction sheet with the dates of the flight, the departure and arrival sites, and the name of the travel agency. Refer to Appendix E for a copy of the informational worksheet given each subject. Each subject was given five minutes to consider his/her approach to the task and a paper and pencil for their use. The subject was instructed to determine the following information from the conversation: the airline, the flight numbers and connection cities, the times of departure and arrival, and the cost. The conversation was audiotaped for later review and rating. Each conversation was timed for completion of task with a maximum time limit of 20 minutes.

Real ear responses. Real ear responses were obtained by routing the broadband noise of the real ear unit through the ATI and the telephone receiver. The real ear unit was calibrated as per the manufacturer's standards. Real ear measures were taken with the monitor and central processing unit (CPU) of the unit out of the booth to avoid electromagnetic interference during telecoil measures (Colville, Bentler, & Elfenbein, 1992). The probe tube measurement system was inserted into the subject's ear canal and the reference mike was taped to the cheek next to the tragus. Consistency of depth of insertion was maintained by using premeasured, marked probe tubes (Hawkins & Mueller, 1992). A calibrated broadband noise was delivered through the ATI and the measurement was taken. The manner in which the subject most commonly used the telephone then determined the telephone to hearing aid coupling strategy measured. Measurement paradigms by strategy were as follows:

Telephone alone. The handset volume control was taped in place at "zero" and the handset was held to the ear. A calibrated broadband noise was delivered through the ATI. Subjects were instructed to position the telephone handset by their ear until the noise was perceived as loudest. This was verified by stability in the response during continuous acquisition. The curve measurement was taken upon verification. No other measurements were taken.

Hearing aid and the telephone (acoustic coupling). The hearing aid was set by the subject to telephone use volume prior to ATI (telephone) word recognition testing. This volume was then maintained for real ear testing. The real ear measurement was taken as in the Telephone Alone paradigm. The handset volume control was taped in place at "zero" and the handset was held to up to the hearing aid. A calibrated broadband noise was delivered through the ATI. Subjects were instructed to position the telephone handset by their hearing aid until the noise was perceived as loudest. This was verified by stability in the response during continuous acquisition. The curve measurement was taken upon verification. An unamplified response was also taken as in the Telephone Alone paradigm.

Amplified handset alone. The handset volume control was set at use prior to ATI (telephone) word recognition testing and taped in place. A calibrated broadband noise was delivered through the ATI. Subjects were instructed to position the telephone handset by their ear until the noise was perceived as loudest. This was verified by stability in the response during continuous acquisition. The curve measurement was taken upon verification. An unamplified response was also taken as in the Telephone Alone paradigm.

Telecoil (eletromagnetic coupling). The hearing aid was set to "telecoil" and use volume by the subject prior to ATI (telephone) word recognition testing. The handset volume control was taped in place at "zero" and the handset was held to up to the hearing aid. A calibrated broadband noise was delivered through the ATI. Subjects were instructed to position the telephone handset by their hearing aid until the noise was perceived as loudest. This was verified by stability in the response during continuous acquisition. The curve measurement was taken upon verification. An unamplified response was also taken as in the Telephone Alone paradigm.

Amplified handset and hearing aid (acoustic coupling). The handset and hearing aid volume controls were set at use prior to ATI (telephone) word recognition testing and the former was taped in place. A calibrated broadband noise was delivered through the ATI. Subjects were instructed to position the telephone handset by their ear until the noise was perceived as loudest. This was verified by stability in the response during continuous acquisition. The curve measurement was taken upon verification. An unamplified response was also taken as in the Telephone Alone paradigm.

Amplified handset and telecoil (electroacoustic coupling). The hearing aid was set to "telecoil" and use volume by the subject prior to ATI (telephone) word recognition testing. The use volume of the handset was taped in place simultaneously. The handset was held to up to the hearing aid. A calibrated broadband noise was delivered through the ATI. Subjects were instructed to position the telephone handset by their hearing aid until the noise was perceived as loudest. This was verified by stability in the response during continuous acquisition. The curve measurement was taken upon verification. An unamplified response was also taken as in the Telephone Alone paradigm.

Completion of the SPAT versus the simulated conversation was counterbalanced from subject to subject to avoid order effects. The above described test protocol was initially completed on ten pilot subjects with varying degrees of hearing loss in order to verify the test parameters, establish the feasibility of the protocol, and provide practice tapes for the two individuals who served as conversation raters.

A data code book was developed for the SPAT and the SPAT-CP. Data was entered into a proprietary database computer program (Paradox for Windows version 1.0, Borland International, Scotts Valley, CA, 1992) by the principal investigator. Data analysis was conducted using a proprietary statistical programs, Statistical Analysis Software (SAS)(SAS Institute, Cary, North Carolina, 1995), S+ (StatSci, Seattle Washington, 1995), and Paradox for Windows version 1.0 (Borland International, Scotts Valley, CA, 1992) .

Reliability of the SPAT and SPAT-CP was examined using a coefficient alpha providing a rating of inter-item consistency (Cronbach, 1951; Kaiser & Michael, 1975; Novick & Lewis, 1967). Significance of the relationships between the SPAT and SPAT-CP and other indicators was determined using a two-tailed Pearson Correlation. The relationships between the scores of the TeleTOPICON raters were examined for agreement using a Kappa Statistic, ordering tendencies with a Pearson Correlation and bias with a Paired t-test.

Results

Hearing Aid History

Subjects were predominately using binaural fittings. Thirty-six subjects wore binaural fitting with 6 subjects fit monaurally in the right ear, and 2 subjects monaurally fit in the left ear. Two subjects wore contralateral routing of the signal or CROS instruments and one subject did not use a hearing aid. Figure 3.1 depicts types of hearing aid fittings.

Hearing aid styles varied, however the majority of fittings or 23 subjects used linear in-the-ear (ITE) instruments and a additional 6 subjects used digital hybrid ITE's. Two subjects were fit with linear half-shell instruments. Canal style instruments accounted for 7 subjects, 5 linear fittings and 2 digital hybrid fittings. Two subjects were using linear behind-the-ear (BTE) fittings and 4 were fit with digital hybrid BTE's. As noted above, 2 subjects had CROS fittings, specifically Bi-CROS or bilateral routing of the signal hearing aids and 1 subject did not use a hearing aid. Figures 3.2 through 3.6 depict percentage of subjects using each style by style and circuitry options.

Years of hearing aid use ranged from "never used a hearing aid" (1 subject) to "used a hearing aid for 20 years" (5 subjects). The average years of use was 7 years 5 months with a standard deviation of 6 years 8 months. The subjects' current hearing aids were however relatively new with an average age of 2 years 6 months. Seven subjects had hearing aids which were less than 1 year old while 2 subjects had 10 year old fittings.

Hours of daily hearing aid use ranged from 9 individuals who do not use the hearing aid on a daily basis to 12 subjects who use the hearing aid more than 16 hours per day. Half of the subjects (23 of the 46 hearing aid users) wear their hearing aids more then 12 hours per day with a maximum use of 18 hours reported by 2 subjects. Average daily use was 9 hours 20 minutes with a standard deviation of 6 hours 20 minutes. Refer to Figure 3.7 for a breakdown of daily hearing aid use.

Telephone Coupling Strategies and Use

Twenty subjects (42.6%) noted using the telephone without any form of amplification. These subjects reported taking their hearing aids out to use the telephone. Eight individuals (17.0%) reported using the hearing aid set on microphone with the telephone and 4 (8.5%) noted using their telecoils. Five individuals (10.6%) used amplified handsets alone and an additional 5 (10.6%) used telephone amplifiers of various types. Four individuals (8.5%) used a telephone amplifier and their hearing aids set on telecoil while 1 individual (2.1%) reported using a telephone amplifier with their hearing aid in their ear, but turned off.

The hearing aids were checked for presence of a telecoil and subjects were asked if they use the telecoil feature. Twenty-one of the 46 subjects (45.7%) with hearing aids have at least one hearing aid with a telecoil. Nine of the subjects (19.6%) noted using the telecoil feature while 12 (26.1%) did not. Eight subjects (17.4%) had hearing aid with telecoils that were malfunctioning or broken upon electroacoustic examination.

Five subjects noted they do not use the telephone on a daily basis, while 38 subjects reported making 2 or more telephone calls per day. The average number of reported telephone calls was 5.44 with a standard deviation of 5.29. The maximum number of telephone calls was 25 as reported by a subject employed as a personal assistant/secretary. Refer to Figure 3.8 for a breakdown of number of calls per day by subject.

Hearing Evaluation Results

Each subject's test results consisted of a standard audiogram with pure tone averages calculated for both ears using 2 frequency (500 and 1000 Hz), 3 frequency (500, 1000, and 2000 Hz) and 4 frequency calculations (1000, 2000, 3000, and 4000 Hz). The 2 frequency average was 38.46 dB HL, the 3 frequency was 43.33 dB HL, and the 4 frequency was 59.07 dB HL for the right ear . The left ear averages were 44.84 dB HL for the 2 frequencies, 51.17 dB HL for the 3 frequencies, and 63.04 dB HL for the 4 frequencies. The subjects' average audiogram with standard deviations can be found in Table 3.3.

Average speech recognition thresholds were 43.42 dB HL for the right ear and 51.70 dB HL for the left ear. Speech recognition scores ranged from 20 dB HL to 110 dB HL for the right ear and 20 dB HL to 115 dB HL. Average word recognition scores for the NU6 lists under headphones were 70.51% with a standard deviation of 24.06 for right ear and 64.17% with a standard deviation of 26.15 for the left ear. Scores ranged from 0-100% for both ears.

Table 3.3 Average audiogram with standard deviations for 47 subjects

Hz	250	500	1.5K	1K	2K	3K	4K	6K	8K
R dBHL	35	35	40	50	55	65	75	80	85
STD	18.1	18.0	17.0	16.3	14.6	16.8	17.3	19.5	20.1
L dBHL	40	40	50	55	60	70	75	80	85
STD	20.6	21.4	19.0	17.8	17.8	16.7	16.7	21.3	23.1

Seventeen subjects noted they most frequently use the right ear for the telephone, 1 subject uses either ear (selected right ear for testing) and 29 subjects noted using the left ear. Reasons for using a particular ear to couple to the telephone varied among subjects. Thirteen subjects (27.7%) write with the opposite hand, 14 (29.8%) noted having better hearing in the telephone ear, 10 (21.3%) noted they used that ear due to habit, 5 (10.6%) had the telecoil in that ear, and 2 (4.3%) noted they used the telephone on the same side as their writing hand. One subject (2.1%) noted using the hand on the side opposite their hearing aid ear, 1 (2.1%) noted using either ear and 1 (2.1%) reported a disability in the opposite hand.

An average audiogram for the right telephone ear, left telephone ear, and overall telephone ear can be found in Table 3.4. The 3 frequency pure tone average for the telephone ear was 44.08 dBHL with a standard deviation of 9.82 and ranged from 30 dB HL to 65 dB HL.

The average speech recognition threshold score for the telephone ear was 46.38 dB HL with a range of 20 to 80 dB HL. Average word recognition score using NU#6 lists under headphones for the telephone ear was 69.96% with a standard deviation of 21.47 and a range from 12 to 100%. Average word recognition score using the ATI in quiet on the telephone ear was 63.28% with a standard deviation of 23.45 and a range in scores from 0 to 96 %. Average word recognition score using the ATI in noise on the telephone was 57.02% with a standard deviation of 24.28 and with a range of 0 to 92%.

Table 3.4 Average telephone ear audiograms with standard deviations for 47 subjects, depicts right ear, left ear and overall telephone ear.

Hz	250	500	1K	1.5K	2K	3K	4K	6K	8K
R dBHL	30	30	35	45	50	50	70	70	75
STD	12.0	11.1	15.5	15.5	14.8	14.8	22.9	25.4	27.2
L dBHL	35	35	30	45	50	65	75	80	85
STD	14.8	14.2	12.0	14.2	9.0	12.0	13.4	14.8	20.1
Over-all	35	35	40	50	55	65	75	75	80
STD	14.3	13.4	13.2	12.9	9.9	12.4	14.6	19.2	20.9

SPAT and SPAT-CP Results

The SPAT and SPAT-CP individual item scores were added to obtain an overall score with higher scores indicating better perceived telephone communication abilities. Certain statements (item numbers 1, 4, and 6) in which a positive answer indicates a negative perception of skill required "negative scoring." Overall scoring on the SPAT and SPAT-CP were derived through attributing a value of 1 to 4 for each answer on each statement. Lower score values are assigned to ratings which indicate poorer telephone skills. Questions 3 and 9 were neutral and not used in the overall score. An overall score of 32 would be the highest score attainable and indicate a high self or partner rating while 8 would be the lowest score indicating a poor self or partner rating.

The mean score on the SPAT was 20.21 with a standard deviation of 4.17 and a range of 13 to 30. The mean score on the SPAT-CP was 19.66 with a standard deviation of 3.82 with a minimum score of 13 and a maximum of 28. The correlation between the SPAT and SPAT-CP was .57 using a two-tailed Pearson Correlation Coefficient This correlation was significant at p=.0001 suggesting a positive relationship between the SPAT score and the SPAT-CP score.

The Cronbach Coefficient Alpha for the SPAT using standardized variables was .83. The .83 coefficient would suggest high internal consistency among the rating statements. The statements "I have no trouble understanding telephone conversations if the room is noisy" and "I do not like to use the telephone" have the lowest correlation with the total at .32. If these questions are removed from the total (leave one out alpha), the alpha rises to .84 in each case. The statements "I often misunderstand conversations over the telephone" and "In general I hear well over the telephone" have the highest correlation with the total at .74. If these statements are removed from the total, the alpha correlation drops to .79 in each case.

The Cronbach Coefficient Alpha for the SPAT-CP using standardized variables was .86 and again suggest high internal consistency among the statements. The statements "My partner has no trouble understanding telephone conversations if the room is noisy," "My partner does not like to use the telephone," and "My partner seldom asks someone else to talk for him/her on the telephone" have the lowest correlations with the total at .48, .41, and .44 respectively. If these questions are removed from the total (leave one out alpha), the alpha remains at .86 for the former and slightly increases to .87 for the latter two statements. The statements "My partner often has to ask people to repeat during telephone conversations" and "My partner does not have trouble understanding friends over the telephone" have the highest correlation with the total at .78. If these statements are removed from the total, the alpha correlation drops to .83 in each case.

TeleTOPICON Results

Two independent trained raters (certified audiologists who specialize in aural rehabilitation) rated the conversation for completion of task, successful use of communication strategies, and monitor time to complete the task. The rating scale was based upon TOPICON (Erber, 1985), a standard methodology for judging conversational effectiveness. TOPICON was modified to include a numerical rating of 1(low) to 5(high) for statistical purposes. Both raters participated in an instructional session to introduce the TeleTOPICON form and address their questions. Raters were asked to give an overall fluency rating and rate the subject based on individual conversational fluency factors. Each rater's overall fluency score and an average of the two raters' overall fluency score and the audiologic test results obtained were utilized for data analysis. Refer to Appendix F for a copy of the rating sheet, Appendix G for the raw scores on the overall and individual conversational fluency factors, and Appendix H for the statistical analysis of agreement between the two raters on the TeleTopicon.

No subject exceeded the 20 minute time limit. The average overall rating given by the first rater was 4.62 with a median score of 5.0 and a range from 2.0 to 5.0. The second rater had a mean score of 3.36 with a median score of 4.0 and a range of 1.0 to 5.0. Agreement between the raters as determined by a Kappa statistic for agreement within one unit was 0.173. A Kappa of 0.173 would be viewed as statistically significant ($p<.05$), and would suggest poor agreement between raters (Landis & Koch, 1997). The Pearson correlation between raters was .48 ($p=0.0006$) suggesting a significant positive relationship between the scores suggesting the raters had a tendency to rate subjects in the same order or direction. A pairwise comparison between the raters using a paired t-test suggested a significant bias among the raters ($p<.0001$) with one rater tending to rate higher than the other. The presence of significant bias in combination with a significant tendency to rate subjects in the same direction would essentially preclude good agreement.

Real Ear Test Results

Real ear testing was completed on 35 of the subjects with hearing impairment. Testing was not completed on the remaining twelve subjects due to equipment failure. Sixteen of the 35 subjects evaluated with real ear probe microphone measurements did not use any form of amplification when listening over the telephone while the remaining 19 use some form of amplification. The results of actual telephone use, both the non-amplified and amplified subjects were combined to develop the Real Ear Phone Response (REPR). The average REPR curve with standard deviations is depicted in Figure 3.9. An average of the subjects' REPR at 1000 Hz, 1500 Hz and 2500 Hz was taken to mimic the average full-on gain of 1000 Hz, 1600 Hz and 2500 Hz as delineated in the hearing aid electroacoustic test paradigm (ANSI S3.3-R1990). The latter average was 16.62 with a standard deviation of 12.70.

Table 3.5 delineates the average test results and statistical information for the subjects' hearing evaluation, word recognition with the ATI, real ear testing, SPAT/SPAT-CP scales, and TeleTOPICON.

Table 3.5 Statistical data for Audiometric, SPAT/SPAT-CP and TeleTopicon scores

Variable	Mean	STD	Median	Minimum	Maximum
Phone Ear 3 freq PTA dBHL	44.08	9.82	42.50	30.00	65.00
Word Rec. Headphones	69.96 %	21.47	80.00	12.00	100.00
ATI word rec. noise	57.02 %	24.28	60.00	0	100.00
REPR * ndB	16.62	12.89	12.67	-2.00	52.33
SPAT	20.21	4.17	20.00	13.00	30.00
SPAT-CP	19.66	3.82	20.00	13.00	28.00
Tele-TOPICON Rater #1	4.62	0.68	5.0	2.0	5.0
Tele-TOPICON Rater #2	3.36	1.03	4.0	1.0	5.0
Tele-TOPICON Average Raters #1 and #2	3.99	0.74	4.0	1.5	5.0

*REPR for 35 subjects only due to equipment failure

Correlation Results

Determinations of which correlations to run were based upon the initial specific aims and research questions as delineated in Chapter 1. Correlation results with statistical significance noted can be found in Table 3.6. The initial aim was to develop a self-rating scale for individuals with hearing loss regarding their patterns and strategies of telephone use, the SPAT. The research questions and resultant correlations are as follows:

1. Does degree of hearing loss as measured by pure tone average (500 Hz, 1000 Hz, and 2000 Hz) correlate with self-rating of telephone communication ability? The Pearson correlation between these variables was not significant (p=0.1408)

2. Does word recognition score as measured by percentage correct on the Northwestern University #6 word lists under headphones correlate with self-rating of telephone communication ability? The Pearson correlation was .34 suggesting a positive relationship which was significant (p=0.0196).

3. Does word recognition score as measured by percentage correct on the Northwestern University #6 word lists using a telephone handset via an Audiometer Telephone Interface (ATI) in a noisy environment correlate with self-rating of telephone communication ability? The Pearson correlation was .48 suggesting a significant positive relationship (p=0.0006).

4. Does frequency/intensity response curve of the preferred telephone listening strategy as measured by real ear probe

microphone instrumentation correlate with self-rating of telephone communication ability? The Pearson correlation was not significant (p=0.15).

5. Does the subject's self-perception of impairment level as measured by SPAT correlate with the SPAT rating given by his or her communication partner? The Pearson correlation was 0.57 suggesting a significant positive relationship (p=0.0001)

The second aim was to develop a simulated interactive telephone conversation to evaluate current communication strategies and overall conversational fluency during telephone use. The research questions and resultant correlations are as follows:

1. Does degree of hearing loss as measured by pure tone average (500 Hz, 1000 Hz, and 2000 Hz) correlate with score on simulated telephone task? The Pearson correlations for pure tone average as compared to either rater or the mean of the raters' scores were not significant.

2. Does word recognition score as measured by percentage correct on the Northwestern University #6 word lists under headphones correlate with score on simulated telephone exercise? Word recognition under headphones was positively correlated to the scores of both raters and their mean scores at p=0.0154 for Rater 1, p=0.0409 for Rater 2 and p=0.0107 for the mean of the raters.

3. Does word recognition score as measured by percentage correct on the Northwestern University #6 word lists using a

telephone handset via an ATI in a noisy environment correlate with score on a simulated exercise? Word recognition using the ATI in noise was positively correlated to the scores of both raters and their mean scores at p=0.0032 for Rater 1, p=0.0282 for Rater 2 and p=0.0037 for the mean of the raters.

4. Does frequency/intensity response curve of the preferred telephone listening strategy as measured by real ear probe microphone instrumentation correlate with score on a simulated exercise? The Pearson correlations for real ear measures as compared to either rater or the mean of the raters' scores were not significant.

5. Does conversational fluency as measured by a simulated telephone exercise correlate with the SPAT score? The exercise score and the SPAT score did not demonstrate a significant correlation for Rater 1, however the correlation was positive and significant for Rater 2 (p=0.0008) and the mean of the Raters (p=0.0028).

6. Does conversational fluency as measured by a simulated telephone exercise correlate with the SPAT score given by the communication partner? The Pearson correlations for the SPAT-CP score as compared to either rater or the mean of the raters' scores were not significant.

Table 3.6 Results of the correlation analysis.

Variable		**3 Freq Pure tone Average**	**Word Recog. Headphones**	**Word Recog. ATI in Noise**	***REPR**	**SPAT**	**SPAT-CP**
SPAT	a	-0.218	0.340	0.481	-0.025	N/A	0.566
	b	0.141	0.020	0.001	0.150		0.001
	c		**	**			**
Rater 1	a	0.104	0.352	0.421	-0.070	0.214	0.133
	b	0.488	0.015	0.003	0.688	0.148	0.372
	c		**	**			
Rater 2	a	-0.217	0.299	0.320	0.133	0.472	0.258
	b	0.143	0.041	0.028	0.447	0.001	0.080
	c		**	**		**	
Average Raters	a	-0.104	0.369	0.415	0.063	0.427	0.240
	b	0.489	0.011	0.004	0.717	0.003	0.104
	c		**	**		**	

*n=35 for REPR, n=47 for all other variables
(a) Pearson Correlation Coefficients
(b) Prob > [R] under Ho
(c) ** statistically significant, $p<0.05$

Results from Subjects with high SPAT Scores

Subject #12 had the highest self-rating on the telephone with a SPAT score of 30. The raters agreed with this self-rating giving conversational ratings on TeleTOPICON of 5 and 4. Subject #12 used the left ear on the telephone as he writes with his right hand. He was 68 years 4 months old and has used hearing aids for 17 years. His current hearing aids are a binaural fit, 7 year old Unitron UI 1 all in the ear style hearing aids. The left ear hearing aid has use setting full-on gain of 27 dBSPL and a use SSPL 90 of 103 dBSPL. He does not use any amplification on the telephone. His spouse rated his telephone skills as a 25 on the SPAT-CP. His left ear has a mild gently sloping to moderate-severe sensorineural hearing loss with an SRT of 40dB HL and 100% word recognition score at +40dB SL. His word recognition in quiet using the ATI was 84% and his word recognition in noise using the ATI was 92%. His REPR average was low at 8.67 dB.

Subject #33 had the second highest self-rating on the telephone with a SPAT of 29 and conversational ratings on TeleTOPICON of 5 from both raters. Subject #33 was 55 years 1 month and has used hearing aids for 9 years with her current fitting being 2 year old 3M programmable all in the ear instruments. She noted using her right ear on the telephone as it is her "better ear" and she reported using the telephone with her hearing aid in on microphone setting. The right hearing aid use gain is 16.5 dB SPL with a use SSPL 90 of 97.5 dBSPL. Her communication partner was a friend who rated Subject #33 as a 23 on the SPAT-CP. Subject #33's right ear has normal hearing levels through 500 Hz with a mild-moderate sensorineural loss through 4000 Hz, again dropping to a severe loss in the higher test frequencies. Her right SRT is 25 dB HL and right ear 96% word recognition. Her word recognition in quiet is 92% using the ATI and 76% in noise using the ATI. Her REPR average was 11.67 dB.

Results from Subjects with low SPAT Scores

Two subjects gave the lowest self-rating scores of 13. Subject #5 gave himself a SPAT of 13, however rater conversation scores on TeleTOPICON were 5 and 4. Subject #5 was 69 years 6 months old and had used hearing aids for 20 years. His current Finetone FC canal style hearing aids were 2 years old. He used the telephone on the right ear as he is left-handed and he noted using the telephone with his right ear hearing aid in and set on microphone. The right ear hearing aid has a use full on gain of 38.5 dB SPL with a use SSPL 90 of 109.5 dB SPL. The aid was noted to have high levels of harmonic distortion of 35% at 500 Hz. His communication partner, a family friend rated his telephone skills as 17 on the SPAT-CP. Subject #5's right ear has sensorineural hearing loss of mild degree through 1000 Hz dropping to a severe loss at 1500 Hz. His SRT is 55 dB HL with word recognition of 56% under headphones. His ATI word recognition in quiet was 65% and his ATI word recognition in noise was 0%. His REPR was 36.33 dB.

Subject #41 also rated himself as a 13 on the SPAT with TeleTOPICON conversational ratings of 4 and 5. Subject 41 was 56 years old and has used hearing aids for twelve years. His current set of Argosy Eclipse canal style hearing aids are 2 years old. He uses the telephone with an amplified handset, no hearing aid, on his left ear as he writes with his right hand. The left ear hearing aid at use settings has a full-on gain of 45 dB SPL with an SSPL90 of 112.5 dB SPL. His communication partner was a family friend who also rated him as a 13 on the SPAT-CP. His SRT was 60 dB HL with 88% word recognition under headphones. His ATI word recognition in quiet was 0% with a noise score of 4%. His REPR could not be evaluated due to equipment problems.

Communication Partner Hearing Evaluation Results

Twenty-four communication partners volunteered to have their hearing tested. An average pure tone audiogram of the communication partners can be found in Table 3.7 Results of the audiogram compared to acknowledgement of hearing loss by the communication partners can be found in Table 3.8.

Table 3.7 Average audiogram for communication partners, n=24

Hz	250	500	1K	2K	4K	8K
R dBHL	20	20	15	20	35	40
STD	9.9	11.5	13.9	18.6	22.5	29.5
L dBHL	25	20	20	30	40	45
STD	22.5	23.5	22.7	24.5	23.7	25.5

Table 3.8 Communication partner's awareness of hearing loss

	Hearing loss on Audiogram	No hearing loss on audiogram
Reports hearing loss	10	0
Does not report hearing loss	6	4
Does not know if has hearing loss	4	0

The six communication partners who did not report a hearing loss, but whose audiogram test results suggest a loss were found to have mild-moderate predominately high frequency losses. The four subjects who did not know if they had a loss and were found to have losses, also had mild-moderate high frequency losses.

Discussion

The stated purpose of this study was to develop clinical tools to measure telephone communication skills of individuals with hearing impairments. A TOPICON based rating of a simulated telephone conversation used in conjunction with a self-perception and significant other perception of telephone ability scale was thought to be more realistic and multidimensional. The simulated conversation rating and the self-perception scales would therefore provide more clinically relevant information from which to measure telephone amplification devices and from which to develop telephone rehabilitation instructional plans and counseling session formats. The structure of the study was to first question hearing aid users regarding their perceptions of hearing aid to telephone compatibility and to use those perceptions to develop two pilot rating scales, the SPAT and the SPAT-CP. The reliability of the scales was then established as detailed in Chapter 2 with the secondary goal of shortening the scales for clinical use. The final part of the study was to then initiate measures of validation of the scales using 47 communication partner pairs.

The subjects used in the validation measures were limited to a given age range to emphasize to the specific needs of the healthy "young-old" adult. Hearing loss criteria were also applied to find subjects with hearing impairments serious enough to effect without precluding telephone use. These goals were achieved as subjects varied in age from 55 to 71 years and had varying hearing impairments within the predetermined specified range.

Communication partners varied in their relationships with the subjects with most being spouses of the subject. The purpose of the study was not however to limit the role of the communication partner to the spouse as individuals need to use the telephone to communicate with a variety of individuals. This study found individuals with hearing loss and their communication partners correlated in their measurement of the subject's ability to communicate on the telephone. While this correlation between the SPAT and SPAT-CP existed, the SPAT-CP did not correlate with the scores assigned to the conversation by the raters. This lack of correlation may reflect upon the diversity of the partner to subject relationships. Studies which have examined the perceptions of the communication partner have traditionally used family members living in the same house (Beattie, 1981; Hetu & Getty, 1991; Hetu, Jones, & Getty, 1993; Oyer & Oyer, 1985; Oyer & Paolucci, 1970; Pedley, 1989; Wood & Kyle, 1983). This study did not make that requirement and the diversity of the relationships could reveal a lack of knowledge about the true communication skills of the subject. An alternative explanation for the lack of correlation may be the nature of the majority relationship of marriage. Retired married couples living together may not need to use the telephone to communicate with each other on a regular basis. The spouse would not therefore have a knowledge of the telephone communication skills of the individual with hearing loss.

Subjects in this study reflect national trends in use of amplification. National use trends described in marketing surveys conducted by the Hearing Industries Association and by specific manufacturer marketing surveys would suggest an increase in binaural fittings, decrease in new users, and a decrease in replacing current systems (Kochkin, 1996). Kochkin notes a 30 percent increase in binaural fittings between 1984 and 1994 with 51.9% of all hearing aid wearers now having binaural fittings. The current subject group has 89% with binaural fittings. Kochkin also reports an increase in return sales versus new users with sales to new users accounting for only 30% of all sales. The current study has 9 or 19.6% users (subjects who never wore an aid before, fit within the last year) and 22 or 47.8 % of subjects on at least their second fitting. National average age of current fitting is also increasing from 3.2 years in 1991 to 4.1 years in 1994 while the average age of instrument for this study was 7.41 years.

The issues related to validation of the self-rating form addressed in the introduction of this chapter were addressed by the research design and in the correlation analysis of the research questions. The initial question, of the face validity or logical consistency between the content of the test items of the SPAT scale statements and ability to rate telephone communication performance was addressed through using the open-ended questionnaire results to plan the SPAT, and the use of disconcordance/concordance and alpha correlation measures to refine the forms. Pre-planning the forms based upon actual complaints reinforced by statistical analysis leads to logical consistency.

The second validation issue of the empirical connection between the performance on the chosen indicator (the SPAT) and some other indicator that purports to measure the same construct was then examined through the series of research questions and subsequent correlations. Audiologists use several tests to determine telephone skill potential. The known and often used indicators of telephone hearing ability include a traditional pure tone average (500 Hz, 1000 Hz, & 2000 Hz) and word recognition scores in quiet under headphones. The former was not significant, however this correlation may have been effected by the limitations placed on hearing levels of participating subjects. The aim of the current study was to examine the skills of individuals with hearing loss who could be expected to experience some difficulty on the telephone, but who can use the telephone via auditory input. The latter significant correlation between self-reported skills and word recognition under headphones is encouraging as word recognition under headphones is a common readily administered clinical tool and therefore warrants further attention as an indicator of telephone use potential.

The other telephone use indicators, word recognition using a telephone in a noisy background and real ear measures are not as common a part of the clinical armamentarium. The correlation between the SPAT and the former was significant. Again, this finding is encouraging as this suggests inherent logical consistency and an empirical relationship established between the content of the test items in this case the SPAT scale statements and the definition of the construct, i.e. ability to rate telephone communication performance.

Real ear measures as described in this chapter were not significantly correlated to the SPAT scores. This finding may also be viewed as suspect due to the significant equipment problems experienced during the study. Equipment failures limited the number of individuals who could participate and the lower subject number may have effected the correlation results.

The third question related to validation of the SPAT addresses the empirical connection between the chosen indicator (SPAT) and other indicators of the same construct (ability to rate telephone communication performance) that use different measurement methods. This issue was addressed by using two audiologists who specialize in aural rehabilitation to rate conversational ability on the telephone using a simulated conversation involving a pre-determined topic. The exercise score and the SPAT score correlated for both Rater #2 (p=0.0008) and the average of both raters (p=0.0028). suggesting a connection between the two conversational rating paradigms.

A significant correlation was not obtained for Rater #1. This lack of correlation with Rater #1 and the SPAT scores may be an effect of the TeleTOPICON scale format. Rater #1's scores topped out the scale with a median score of 4 and a more restricted range of 2 to 5. The TeleTOPICON's scale of 1 to 5 may be too restrictive for measuring a diverse skill as telephone communication.

This area of validation again needs further exploration to determine why the raters differed in their use of the scale and which factors each rater used to make scoring judgements. Suggestions for improving TeleTOPICON include expanding the scale, and developing rater training based upon scoring factors.

The high TeleTOPICON scores may also have been effected by the conversational task. The task was very structured. Subjects were giving time to plan the conversation and held written instructions throughout the conversation. Further validation of TeleTOPICON should use less structured conversational situations with fewer written instructions and less preparation time.

The fourth area of validation which involves establishing that the indicator of a construct, SPAT score does not correlate with indicators of other constructs that are theoretically unrelated to the first. This area was not addressed by this study and requires further examination. One possible strategy would be to compare the SPAT scores with self-reported scores of written forms of communication or other non-auditory forms of communication.

Involvement of the communication partner permitted other correlation analyses. The SPAT score was found to be positively correlated to the SPAT-CP at a significant level. The SPAT-CP and the rater's individual scores or mean score were not however significant. This would suggest the communication partner agrees with the perceptions of the individual with hearing loss, but does not correlate to the raters' perceptions of the individual's skills. This result would suggest the need for further research in the area of defining telephone communication skills. The subjects and their communication partners may have based ratings upon slightly different specific communication skills. These slight differences may then translate to lack of correlation with the conversational raters.

Involvement of the family/community dynamic in relation to adjustment to hearing impairment is an area which begs further research (Beattie, 1981; Hetu, Jones, & Getty; 1993; Lalande, Lambert & Riverin, 1988; Newman & Weinstein, 1986). Specific questions for this study include:

1. Does the type of relationship, i.e. significant other, child, friend, effect the ability of the communication partner to rate telephone conversational skills?
2. Is ability to rate telephone conversational skills effected by the communication partner having a hearing loss?
3. Does the gender of the communication partner in relation to the individual with hearing loss effect the SPAT-CP score?

The two objectives of the study, i.e. to design the SPAT and SPAT-CP and to design and use a conversation based rating system to measure telephone conversational abilities were achieved. One of the more promising findings was the correlation between word recognition scores under headphones with the SPAT score. Word recognition testing is a common clinical technique which does not involve extra equipment, time or expense. Further research in the area should determine if half-list presentations (25 words) maintain the correlation and if changing the word lists effects the correlation.

Areas of further research should also include continued development of the SPAT and SPAT-CP, expansion of the Tele-TOPICON scale, and continuing work into telephone amplification. The former would include exploring the issues related to the communication partner as delineated above, using the forms with differing populations, expanding the form to address the use of telephone conversational strategies, and beginning treatment/counseling efficacy studies with the SPAT and SPAT-CP.

Further research into the TeleTOPICON include exploration of how the specific skills synergies into the overall conversational rating, examining inter and intra-rater consistency, and expanding the rating scale. Work on both the SPAT forms and the TeleTOPICON should aid in the area of telephone amplification research. As noted in the introduction of this study, telephony and amplification of the telephone are rapidly changing technologies and research into use of the telephone by individuals with hearing loss is a relatively neglected area in the field of audiology. Both the self-rating measures and the conversational rating measures can serve as tools in the area of telephone research and hopefully lead to better, more efficacious treatment and counseling strategies.

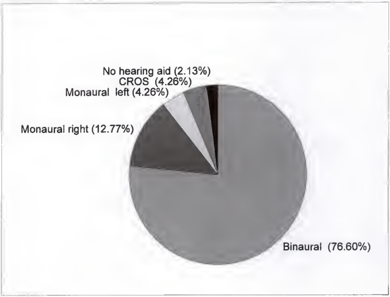

Figure 3.1 Type of hearing aid fitting by percentage of subjects, n=47.

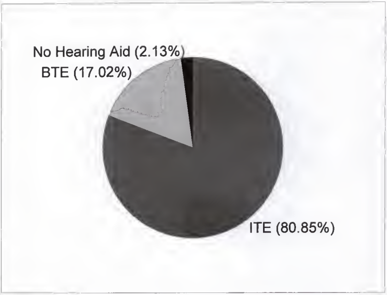

Figure 3.2 Type of hearing aid style, behind-the-ear versus in-the ear by percentage of subjects, n=47.

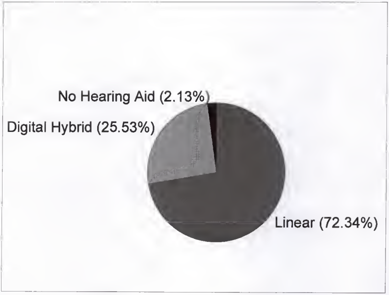

Figure 3.3 Type of hearing aid style, linear versus hybrid circuitry options by percentage of subjects, n=47.

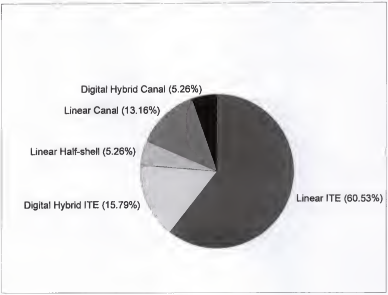

Figure 3.4 Type of in-the-ear fittings by percentage of subjects, n=38.

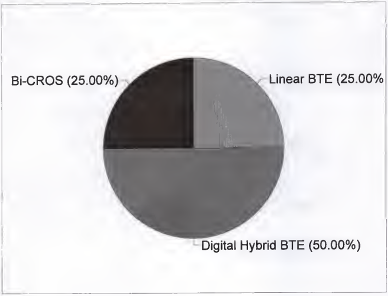

Figure 3.5 Type of behind-the-ear fittings, n=8.

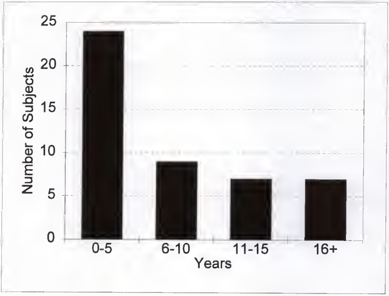

Figure 3.6 Years of hearing aid use, n=47.

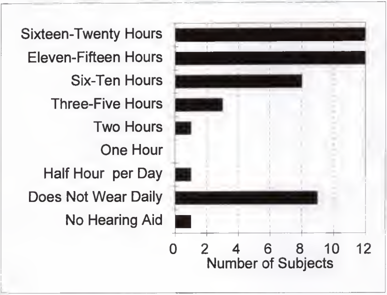

Figure 3.7 Daily hearing aid use by hour, n=47.

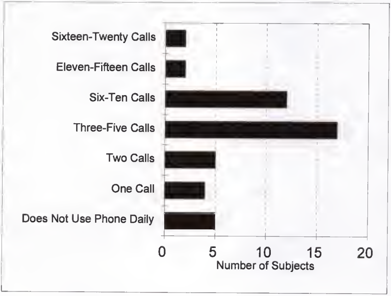

Figure 3.8 Number of telephone calls per day, n=47.

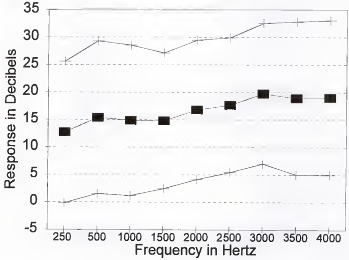

Figure 3.9 Real ear phone response with standard deviations, n=35.

CHAPTER 4
DISCUSSION

Advances in amplification technology, modifications in legislation and regulations, expansion of professional scope for audiologic practice and restructuring of health care reimbursement have increased the need for and importance of self-rating scales in audiology. Generalized scales to measure the effects of hearing loss have existed for over 30 years (High, Fairbanks & Glorig, 1964). Recent changes in service provision and technology have led to the increased use of such generalized scales and to the development of scales for specific populations (Kaplan, Bally, & Brandt, 1991), specific disorders (Jacobson, Newman, Hunter, & Balzer, 1991; Kuk, Tyler, Russell & Jordan, 1990) and specific interventions (Cox & Gilmore, 1990; Tye-Murray, 1993). Telecommunications is a rapidly expanding and ever changing field. The mercurial rise of wireless telephony, the advent of personalized telephone paging systems, and the introduction of new "thin" technology or hand-held computer-telephone units are presented as innovative advances in personal communication for the general public. Unfortunately, these advancements in telephone technology have presented as new obstacles rather than opportunities for individuals with hearing loss.

Recent federal legislation has recognized the importance of telephone access for the disability community and has mandated that the principles of universal service to apply to individuals with disability (Telecommunications Act, 1996). Wireless telephony has spawned federal regulatory initiatives in response to both bystander and user interference with hearing aids. The Federal Communications Commission and the Food and Drug Administration have called for and co-sponsored multi-professional forums, and research efforts to alleviate bystander and user interference between wireless telephone and hearing aids, while the Architectural and Transportation Barriers Compliance Board (Access Board) is currently examining general telecommunications access for all individuals with disabilities as mandated under Section 255 of the Communications Act of 1996. These agencies have called for a cohesive effort on the parts of government, the telephone manufacturers, telephone service providers, hearing aid manufacturers, hearing aid dispensers, audiologists, and the disability community toward the immediate goal of creating telephone access and true universal service. Cohesion between these groups will require the audiology community to develop reliable, valid methods to diagnose, treat, and measure success in telephone to hearing aid coupling strategies.

Proposed and existing hearing aid selection and fitting guidelines also state the need for clinical tools to measure outcomes(ASHA, 1991; Hawkins, Beck, Bratt, Fabry, Mueller, & Stelmachowicz, 1991; Seewald, Ross, & Stelmachowicz, 1987). ASHA's current Preferred Practice Patterns for the Professions of Speech-Language Pathology and Audiology (ASHA, 1993)recommends using self-assessment scales as part of hearing aid fittings. The ASHA Ad-hoc Committee on Hearing Aid Selection and Fitting is currently writing a fitting guideline which recommends the use of self-rating scales to measure treatment outcome, in this case hearing aid satisfaction.

Outcome measures with known reliability and validity are also being demanded by insurers and other third party reimbursement sources (Baum, Swigert, & Gallagher, 1997). Reimbursement is now predicated upon actual personal outcome data and contracts for further service provision are based upon group data demonstrating success. Audiology as a field has been slow in responding to the need for outcome based studies, however several existing self-rating scales have been modified for use in treatment efficacy research (Chmiel & Jerger, 1996; Weinstein, 1993). The SPAT and SPAT-CP were developed to address the need for efficacy data in telephone communication rehabilitation.

The current research also recognizes the importance of the conversational partner as communication occurs between individuals. The SPAT-CP was designed to tap into the communication partner's perceptions of the hearing impaired individual's ability to converse over the telephone. These insights could then be compared to the perceptions of the hearing impaired individual for use in therapy and counseling. Research in aural rehabilitation has recognized the importance of the family and community in the eventual success of the therapy intervention, however a formalized methodology to tap into perceptions related to telephone communication skills has been lacking.

To address the professional need for such a scale and the importance of reliability and validity in self-assessment scales, the first objective of this study was to create a measurement scale based upon actual need or perceived problem. This was accomplished through the use of an open-ended questionnaire on telephone use completed by hearing impaired veterans. Their needs were then translated into statement pairs to create the SPAT and SPAT-CP pilot versions. Information from pilot testing with individuals with hearing loss and their communication partners was then used to determine internal consistency among the items in order to decrease the length of the forms.

Validation of the shortened form was completed by having 47 communication pairs complete the shortened self-rating scales and participate in a simulated telephone conversation. The latter was then evaluated for overall conversational fluency by two audiologists who specialize in aural rehabilitation. The SPAT correlated to the TeleTOPICON scores of Rater # 2 and the mean of the raters. Rater #1's scores did not correlate however, Rater #1 "topped out" the TeleTOPICON scale with a median score of 5 and a restricted rating of 2 to 5. Improvements to the scale, e.g. expanding the numeric ratings to provide for slight difference between subjects and delineating which factors contribute to the overall score are warranted. Conversational measurement strategies should also be examined for structure, time frames, preparation, and instructions.

The finding that word recognition under telephones and word recognition using the ATI in noise are significantly correlated to the SPAT scores is exciting from both clinical and experimental perspectives. Word recognition under headphones is a routine part of the clinical audiometric test battery. This test which would not involve further time, equipment or financial outlay can be used as a predictor of telephone communication ability. Both word recognition under headphones and word recognition using the ATI in noise deserve further exploration. Areas to explore include use of half-lists, use of differing word lists other than the NU6, and varying the type, spectra, and intensity of noise with the ATI.

Further effort to optimize the SPAT-CP needs to be completed prior to clinical use. Results of this study suggest the communication partner's perceptions are not born out by the actual rating of the conversation. Improving the validity and the reliability of both the SPAT and SPAT-CP are imperative to their eventual use as a measure of intervention outcomes. One area to examine is the relationship of the communication partner to the subject with attention paid to the perceptions of significant others living together versus family or acquaintances who do not live in the same dwelling. Areas specific to the forms include re-examining the items used. Possible improvements would include adding items related to communication strategies and their use, items which emphasize amplification strategies, and items which delve into situation or environment specifics.

A second area to address in improving the validity of the SPAT and SPAT-CP would be an examination of the differences in scores per item of the SPAT versus the SPAT-CP in relation to the conversational ratings. If certain items were found to be consistently problematic, then changes in statement wording, elimination of the item or replacement of the item would then be considered.

The current study addressed reliability through examination of inter-item consistency. The next area to address is reliability over repeated administrations over time. Test-retest reliability requires giving the test to the same subjects under similar conditions at different times. High correlations among the scores indicates greater reliability and less error attributable to subject differences.

Continued effort should also be placed on validation of the SPAT and SPAT-CP with the current grouping of young elderly hearing impaired individuals and other groups of individuals with hearing loss. This would include establishing that the SPAT and SPAT-CP are true indicators of telephone communication ability and that they do not correlate with other constructs theoretically unrelated. One possible study would compare SPAT and SPAT-CP scores with self-rated scores of written communication abilities.

Uses for the SPAT and SPAT-CP will be primarily found in aural rehabilitation therapy. Self-rating scales help to establish skill baseline levels from which to develop therapy goals, measure progress, and monitor skills over time. Pre- and post-therapy scores will also serve to prove or disprove the efficacy of the therapy procedure and permit restructuring of the therapy program as necessary. Using the SPAT and SPAT-CP in conjunction permits family/significant other involvement in therapy which can aid in the therapist's and client's understanding of problematic communication areas.

Audiologists may also use the SPAT and SPAT-CP in planning telephone amplification strategies. The SPAT and SPAT-CP could be used to demonstrate benefit from a new or different amplification strategy. For example, the SPAT could be administered prior to fitting a completely-in-the-canal style hearing aid and then again after fitting at a specified time period to demonstrate improved telephone listening in noise. The SPAT-CP could be used in a similar manner with a skeptical spouse to show the benefit of a digital hearing aid with a specialized telephone listening program. Telecoil benefits and telephone amplifier benefits could be demonstrated in the same manner.

Less traditional or less clinically based uses for the SPAT and SPAT-CP can be found in actual telephone purchases and telephone research. Individuals with hearing impairments could use the SPAT to compare types of telephones and telephone to hearing aid compatibility. The latter may be of great benefit in the area of hearing aid compatibility with wireless telephones. Consumers could evaluate their hearing aid's compatibility to a particular wireless telephone by using the SPAT to self-rate their conversational skills.

Current telephone research focuses on making the device smaller and more personalized . The latter trend may actually work in favor of the consumer with hearing loss as amplification needs can be either built into a personalized telephone or transmitted to any telephone via a smart card system. Again, the efficacy of such strategies would need to be established and again a self-rating scale such as the SPAT would be a valid tool in such research efforts.

Telephony is changing and the access to telephones by individuals with disabilities is caught up in that change. At best, technological advances can provide a service to the disability community or at worst, they can hinder further the community's attempts to live normal mainstream lives. The responsibility of the audiologist is to know the current technology and be able to teach optimal use of the technology to his/her clients. The SPAT and SPAT-CP are tools designed to aid in that end.

APPENDIX A
OPEN-ENDED QUESTIONNAIRE

Dear Subject Name:

As an Audiologist at the VA Medical Center in Gainesville, I am interested in finding out about problems you may have with using your hearing aid on the telephone. I would appreciate it if you would take a little time and share your experiences with me.

On the paper provided tell me in your own words if you use the telephone. If you do not use the telephone, please tell me why, and what you think could help you use the telephone better.

If you do use the telephone with your hearing aid, I ask that you tell me about any problems you have with it. Tell me about the problems you may have understanding people on the telephone. Be as general or specific as you like and give me as many examples as you can. And if you have some advice for people using the telephone with their hearing aid, I'd like to know that too.

When you finish your list and comments send it to the Audiology clinic using the enclosed envelope, no postage needed, just put it in the mail. All of the responses are confidential and remain in the Audiology clinic.

I hope that this information you share with me will help Audiologists better meet the needs of you, the hearing aid using veteran. Your personal experiences are a great resource. Thank you for reading this letter and I look forward to hearing from you.

Sincerely,

Robert B. Yanke, M.S.
Audiologist

APPENDIX B
PILOT VERSIONS OF SPAT AND SPAT-CP

TELEPHONE CASE HISTORY

Name:____**Date:**_______

Communication Partner Name:

____

Check the way you most often use the telephone

___Telephone alone ___Amplified Handset

___Telephone and your hearing aid ___Telephone Amplifier

___Telephone and your hearing aid set on T-Coil

How many years have you used a hearing aid? ________________________

How many hours per day do you use your hearing aid? ____________________

How many times per day do you speak on the telephone? ____________________

Does your communication partner have a hearing loss?

____ Yes ____ No ____ I am not sure

The following questionnaire is designed to measure how well you communicate on the telephone. Circle the answer which best tells your opinion. PLEASE GIVE AN ANSWER FOR EACH ONE.

1. I never confuse things when listening over the telephone.

a. strongly agree b. agree c. disagree d. strongly disagree

2. I usually have problems hearing over the telephone.

a. strongly agree b. agree c. disagree d. strongly disagree

3. I can understand men's voices better than women's voices over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

4. I do not have to ask people to repeat when talking over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

5. I always tell people I have a hearing loss when using the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

6. I have no trouble understanding telephone conversations if the room is noisy.
a. strongly agree b. agree c. disagree d. strongly disagree

7. I do not mind using the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

8. I often ask someone else to call for me.
a. strongly agree b. agree c. disagree d. strongly disagree

9. I do not like to use the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

10. I never tell people I have a hearing loss when using the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

11. I seldom ask someone else to talk for me on the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

12. I often have to ask people to repeat themselves during telephone conversations.
a. strongly agree b. agree c. disagree d. strongly disagree

13. I often misunderstand conversations over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

14. I do not have trouble understanding friends over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

15. I can understand women's voices better than men's voices over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

16. I do not have trouble understanding strange voices over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

17. I have difficulty understanding telephone conversations if the room is noisy.
a. strongly agree b. agree c. disagree d. strongly disagree

18. My friends can be hard to understand over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

19. In general I hear well over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

20. I have difficulty understanding strangers over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

TELEPHONE CASE HISTORY-PARTNER FORM

Name: ______________________________________ **Date:** _______

Name of communication partner:

____

Check the way your partner most often uses the telephone

___Telephone alone ___Amplified Handset

___Telephone and hearing aid ___Telephone Amplifier

___Telephone and hearing aid set on T-Coil

Do you have a hearing loss?

____ Yes ____ No ____ I am not sure

The following questionnaire is designed to measure how well your partner communicates on the telephone. Circle the answer which best tells your opinion. PLEASE GIVE AN ANSWER FOR EACH ONE.

1. My partner never confuses things when listening over the telephone.

a. strongly agree b. agree c. disagree d. strongly disagree

2. My partner usually has problems hearing over the telephone.

a. strongly agree b. agree c. disagree d. strongly disagree

3. My partner can understand men's voices better than women's voices over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

4. My partner does not have to ask people to repeat when talking over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

5. My partner always tell people he/she has a hearing loss when using the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

6. My partner has no trouble understanding telephone conversations if the room is noisy.
a. strongly agree b. agree c. disagree d. strongly disagree

7. My partner does not mind using the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

8. My partner often asks someone else to call for him/her.
a. strongly agree b. agree c. disagree d. strongly disagree

9. My partner does not like to use the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

10. My partner never tells people he/she has a hearing loss when using the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

11. My partner seldom asks someone else to talk for him/her on the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

12. My partner often has to ask people to repeat themselves during telephone conversations.
a. strongly agree b. agree c. disagree d. strongly disagree

13. My partner often misunderstands conversations over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

14. My partner does not have trouble understanding friends over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

15. My partner can understand women's voices better than men's voices over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

16. My partner does not have trouble understanding strange voices over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

17. My partner has difficulty understanding telephone conversations if the room is noisy.
a. strongly agree b. agree c. disagree d. strongly disagree

18. My partner says his/her friends can be hard to understand over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

19. In general my partner hears well over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

20. My partner has difficulty understanding strangers over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

APPENDIX C
CONCORDANCE/DISCONCORDANCE MEASURES

Comparison #1

Question #1

I (My partner) never confuse things when listening over the telephone.

versus

Question # 13
I (My partner) often misunderstand conversations over the telephone.

SPAT	SPOUSE
C=180	C=102
D=398	D=628

Comparison #2

Question #2
I (My partner) usually have problems hearing over the telephone.

versus

Question #19
In general I (My partner) hear well over the telephone.

SPAT	SPOUSE
C=54	C=96
D=548	D=732

Comparison #3

Question # 3
I (My partner) can understand men's voices better than women's voices over the telephone.

versus

Question #15
I (My partner) can understand women's voices better than men's voices over the telephone.

SPAT	SPOUSE

C=181	C=360
D=414	D=189

Comparison #4

Question # 4
I (My partner) do not have to ask people to repeat when talking over the telephone.

versus

Question #12
I (My partner) often have to ask people to repeat themselves during telephone conversations.

SPAT	SPOUSE
C=115	C=61
D=497	D=604

Comparison #5

Question #5
I (My partner) always tell people I (My partner) have a hearing loss when using the telephone.

versus

Question #10
I (My partner) never tell people I (My partner) have a hearing loss when using the telephone.

SPAT	SPOUSE
C=138	C=179
D=610	D=569

Comparison #6

Question # 6
I (My partner) have no trouble understanding telephone conversations if the room is noisy.

versus

Question #17
I (My partner) have difficulty understanding telephone conversations if the room is noisy.

SPAT	SPOUSE
C=96	C=104
D=630	D=575

Comparison #7

Question # 7
I (My partner) do not mind using the telephone.

versus

Question #9
I (My partner) do not like to use the telephone.

SPAT	SPOUSE
C=201	C=67
D=682	D=977

Comparison #8

Question # 8
I (My partner) often ask someone else to call for me.

versus

Question #11
I (My partner) seldom ask someone else to talk for me on the telephone.

SPAT	SPOUSE
C=118	C=54
D=694	D=771

Comparison #9

Question #14
I (My partner) do not have trouble understanding friends over the telephone.

versus

Question #18
My (My partner's) friends can be hard to understand over the telephone.

SPAT	SPOUSE
C=56	C=45
D=565	D=668

Comparison #10

Question #16
I (My partner) do not have trouble understanding strange voices over the telephone.

versus

Question # 20
I (My partner) have difficulty understanding strangers over the telephone.

SPAT	SPOUSE
C=116	C=17
D=555	D=775

APPENDIX D
FINAL VERSIONS OF THE SPAT AND SPAT-CP

TELEPHONE CASE HISTORY

Name: ______________________________ **Date:** _______

Social Security #: ____________________ **DOB:** __________

Communication Partner Name:

____

Relationship of Communication Partner to you

___1. Spouse or significant other

___2. Sibling

___3. Parent

___4. Child

___5. Friend, neighbor

___6. Relative other than above

Check the way you most often use the telephone

___Telephone alone

___Telephone and your hearing aid

___Telephone and your hearing aid set on T-Coil

___Amplified Handset

___Telephone Amp

How many years have you used a hearing aid?

___Never used a hearing aid

___Just purchased a hearing aid (less than 6 months)

___6 months to one year

___one year

___give the number of years if more than one

How many hours per day do you use your hearing aid?

___do not use a hearing aid on a daily basis

___less than one hour

___one hour

___give the number of hours if over one

How many times per day do you speak on the telephone?

___do not speak on the telephone on a daily basis

___one time per day

___give the number of times if greater than one

Does your communication partner have a hearing loss?

____ Yes ____ No ____ I am not sure

The following questionnaire is designed to measure how well you communicate on the telephone. Circle the answer which best tells your opinion. PLEASE GIVE AN ANSWER FOR EACH ONE.

1. I often misunderstand conversations over the telephone.

a. strongly agree b. agree c. disagree d. strongly disagree

2. In general I hear well over the telephone.

a. strongly agree b. agree c. disagree d. strongly disagree

3. I can understand men better than women over the telephone.

a. strongly agree b. agree c. disagree d. strongly disagree

4. I often have to ask people to repeat during telephone conversations.

a. strongly agree b. agree c. disagree d. strongly disagree

5. I have no trouble understanding telephone conversations if the room is noisy.
a. strongly agree b. agree c. disagree d. strongly disagree

6. I do not like to use the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

7. I seldom ask someone else to talk for me on the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

8. I do not have trouble understanding friends over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

9. I can understand women better than men over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

10. I do not have trouble understanding strangers over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

TELEPHONE CASE HISTORY-PARTNER FORM

Name:______________________________________ **Date:** _______

Name of communication
partner:__________________________________

Date of Birth: ____________________

Check the way your partner most often uses the telephone

___Telephone alone ___Amplified Handset

___Telephone and hearing aid ___Telephone Amplifier

___Telephone and hearing aid set on T-Coil

Do you have a hearing loss?

____ Yes ____ No ____ I am not sure

The following questionnaire is designed to measure how well your partner communicates on the telephone. Circle the answer which best tells your opinion. PLEASE GIVE AN ANSWER FOR EACH ONE.

1. My partner often misunderstands conversations over the telephone.
 a. strongly agree b. agree c. disagree d. strongly disagree

2. In general my partner hears well over the telephone.
a. strongly agreeb. agree c. disagree d. strongly disagree

3. My partner can understand men better than women over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

4. My partner often has to ask people to repeat during telephone conversations.
a. strongly agree b. agree c. disagree d. strongly disagree

5. My partner has no trouble understanding telephone conversations if the room is noisy.
a. strongly agree b. agree c. disagree d. strongly disagree

6. My partner does not like to use the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

7. My partner seldom asks someone else to talk for him/her on the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

8. My partner does not have trouble understanding friends over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

9. My partner can understand women better than men over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

10. My partner does not have trouble understanding strangers over the telephone.
a. strongly agree b. agree c. disagree d. strongly disagree

APPENDIX E
INSTRUCTIONS FOR TELEPHONE CONVERSATION

INSTRUCTIONS

FEEL FREE TO WRITE ON THIS PAPER.

You are going on a flight from Gainesville, Florida to Seattle, Washington and back. The flight must occur in October of 1995. You are to call your travel agent, TRAVELGATORS for information regarding the flight. This is a business flight, but you do not need a rental car. You need to find out the following information:

1. The name of the airline
2. The flight numbers
3. The connecting cities
4. The times of departure and arrival
5. The cost of the tickets

APPENDIX F
TELETOPICON FORM

TELETOPICON

Name____________________ **Subject#**______________________

Date_____________________ **Rater #**______________________

Communication Task:

Familiarity of Task:

Client	Clinician
___High ___Low	___High ___Low

Time to complete task:

Overall "fluency" of conversation

___ ___ ___ ___ ___

Low(1) High(5)

Factors Related to Fluency

Receptive abilities

___ ___ ___ ___ ___

Low(1) High(5)

Expressive abilities

___ ___ ___ ___ ___

Low(1) High(5)

Motivation, attention

___ ___ ___ ___ ___

Low(1) High(5)

Turntaking, time sharing

___ ___ ___ ___ ___

Low(1) High(5)

Accuracy

___ ___ ___ ___ ___

Low(1) High(5)

Verification

___ ___ ___ ___ ___

Low(1) High(5)

Topic maintenance

___ ___ ___ ___ ___

Low(1) High(5)

Independent Repair

___ ___ ___ ___ ___

Low(1) High(5)

Strategies used:

	TotalSuccessful
Repeat	
Rephrase	
Spell	
Code Words	

Alphabet

Digits

Counting

Confirm

Other:

Comments:

APPENDIX G
TELETOPICON RAW SCORES

This appendix includes the raw scores for the TeleTOPICON by rater. Column titles are as follows:

ID	Subject identification number
IDC	Communication partner identification number
r	Rater number
re	Receptive skills
ee	Expressive skills
m	Motivation
t	Turntaking
a	Accuracy
v	Verify
to	Topic
rp	Repair

ID	IDC	r	f	re	ee	m	t	a	v	to	rp
1	201	1	5	5	5	5	5	5	5	5	5
2	202	1	5	0	5	5	5	5	5	4	5
3	203	1	5	5	5	5	5	0	5	0	0
4	204	1	5	4	5	5	5	5	4	5	5
5	205	1	5	5	5	5	5	5	3	5	6
6	206	1	4	4	5	5	5	4	5	5	6
7	207	1	5	5	5	5	5	5	5	5	6
8	208	1	5	5	5	5	5	5	5	5	0

9	209	1	5	5	5	5	5	5	3	5	6
10	210	1	5	5	5	5	5	5	4	5	5
11	211	1	4	4	5	5	5	4	5	5	6
12	212	1	5	0	5	5	5	5	4	5	0
13	213	1	4	4	5	5	5	4	4	5	0
14	214	1	5	5	5	5	4	0	3	5	6
15	215	1	5	5	5	5	5	5	4	5	6
16	216	1	5	5	5	5	5	5	4	5	5
17	217	1	5	5	5	5	5	5	5	5	0
18	218	1	5	5	5	5	5	5	5	5	5
19	219	1	4	4	4	4	5	5	3	5	6
20	220	1	5	5	5	5	5	5	5	5	0
21	221	1	5	5	5	5	5	5	5	5	6
22	222	1	5	5	5	5	5	5	4	5	6
23	223	1	4	4	5	5	5	5	4	5	0
24	224	1	4	4	5	5	5	5	3	5	6
25	225	1	5	5	5	5	5	5	5	5	0
26	226	1	5	5	5	5	5	5	4	5	0
27	227	1	4	4	5	5	5	4	5	5	0
28	228	1	5	5	5	5	4	5	3	0	0
29	229	1	5	5	5	5	5	5	3	5	0
30	230	1	2	2	5	5	5	0	3	0	6
31	231	1	5	5	5	5	5	5	4	5	0
32	232	1	4	4	5	5	5	5	5	5	0
33	233	1	5	5	5	5	5	5	3	5	0
34	234	1	4	4	5	5	5	5	5	5	6

35	235	1	5	5	5	5	5	5	5	5	0
36	236	1	2	2	5	5	5	4	3	5	0
37	237	1	5	5	5	5	5	5	4	5	0
38	238	1	5	5	5	5	5	5	5	5	0
40	240	1	5	5	5	5	5	5	4	5	0
41	241	1	5	5	5	5	5	5	5	5	0
42	242	1	5	5	5	5	5	5	5	5	0
43	243	1	5	5	5	5	5	5	5	5	0
44	244	1	5	5	5	5	5	5	5	5	0
45	245	1	5	5	5	5	5	5	5	5	0
46	246	1	4	4	5	5	5	4	5	5	0
47	247	1	4	4	5	5	4	4	3	5	0
48	248	1	4	4	5	5	5	5	5	5	0
49	249	1	5	5	5	5	3	0	3	0	0
50	250	1	3	3	5	5	5	3	5	5	0
51	251	1	3	3	5	5	5	4	5	5	0
1	201	2	4	4	4	4	4	3	4	4	3
2	202	2	4	4	3	4	4	3	3	4	2
3	203	2	3	3	4	4	4	3	3	4	2
4	204	2	4	4	4	4	4	3	4	4	3
5	205	2	4	4	4	4	4	4	3	4	3
6	206	2	4	4	4	5	5	4	5	4	4
7	207	2	5	5	5	5	5	5	5	5	5
8	208	2	5	5	5	5	5	5	5	5	5
9	209	2	3	3	3	2	4	4	1	4	5
10	210	2	4	4	5	5	5	4	5	5	5

11	211	2	3	3	4	5	4	2	3	4	3
12	212	2	4	5	5	5	5	4	4	5	2
13	213	2	2	2	3	2	4	2	3	2	2
14	214	2	4	4	5	5	5	3	3	4	4
15	215	2	5	5	5	5	5	4	4	5	4
16	216	2	3	4	3	4	3	4	4	4	3
17	217	2	4	4	4	5	4	4	4	5	4
18	218	2	1	2	3	2	3	2	2	3	1
19	219	2	2	2	2	2	3	2	2	3	2
20	220	2	4	3	4	5	4	4	5	5	3
21	221	2	4	3	4	4	4	4	4	4	3
22	222	2	2	2	3	2	3	2	2	3	1
23	223	2	2	2	4	4	3	2	4	4	3
24	224	2	3	3	3	3	3	2	2	3	2
25	225	2	4	3	4	5	4	3	5	5	3
26	226	2	4	3	2	3	4	3	2	4	2
27	227	2	4	4	5	4	4	4	4	4	2
28	228	2	2	3	3	4	2	3	2	3	2
29	229	2	4	3	4	4	3	3	3	4	2
30	230	2	1	1	3	3	3	1	2	3	1
31	231	2	4	4	4	4	4	5	3	4	2
32	232	2	2	2	3	4	2	2	5	4	3
33	233	2	5	4	4	5	5	4	4	4	3
34	234	2	3	3	4	4	3	3	4	4	3
35	235	2	3	3	3	3	4	3	4	4	3
37	237	2	2	2	3	4	4	2	4	4	2

38	238	2	4	4	4	4	4	4	5	4	3
39	239	2	4	4	4	4	4	4	5	4	3
40	240	2	3	3	4	4	4	4	4	4	2
41	241	2	4	4	4	4	4	4	5	4	3
42	242	2	4	4	4	4	4	3	4	4	3
43	243	2	3	3	3	4	4	3	4	4	3
44	244	2	4	3	4	4	4	3	4	4	3
45	245	2	4	4	4	4	3	5	5	5	3
46	246	2	2	2	4	4	4	2	4	4	1
47	247	2	2	2	2	2	3	2	2	3	2
48	248	2	3	3	3	4	3	2	4	3	2
49	249	2	3	3	3	4	4	4	2	4	3
50	250	2	4	4	4	4	4	3	4	4	2
51	251	2	2	2	3	4	4	2	4	4	2

APPENDIX H
AGREEMENT BETWEEN TELETOPICON RATERS

The following is the statistical analysis of agreement between the two raters on the TeleTopicon. True agreement was examined through a Kappa Statistic, ordering tendencies were examined through a Pearson correlation coefficient, and rater bias was examined with a Paired t-test.

Kappa Statistic for Agreement

Table H1 Data (cross-classified table format).

	1	2	3	4	5
1	0	0	0	0	0
2	1	0	0	0	0
3	0	1	0	1	0
4	0	5	4	2	0
5	1	3	6	19	4

(rows = rater one, columns = rater two)

Table H2 Weight Matrix

	1	2	3	4	5
1	1	1	0	0	0
2	1	1	1	0	0
3	0	1	1	1	0
4	0	0	1	1	1
5	0	0	0	1	1

Sample size: 47
Observed agreement: 68.1% (within one)
Expected agreement: 61.4% (by chance, within one)
Kappa statistic: 0.173 (p-value 1-sided test = 0.032)

Pearson Correlation (ordering tendency)

Table H3 Simple statistics

	N	Mean	Std Dev	Median	Min	Max
Rater 1	47	4.62	0.68	5.00	2.00	5.00
Rater 2	47	3.36	1.03	4.00	1.00	5.00
Rater 2-Rater 1	47	-1.26	0.92	-1.00	-4.00	1.00

Pearson Correlational Coefficient

Rater 1 vs Rater 2 r= 0.48
p= 0.0006

Pairwise Comparison or Paired t-test

Rater 1 vs Rater 2 **$p<.0001$**

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BIOGRAPHICAL SKETCH

Holly S. Kaplan was born December 28, 1960 in Red Bud, Illinois. She is the youngest daughter of Philip John and Laverna Mueller. Holly grew up in Waterloo, a small town in southern Illinois. She was the Valedictorian of her graduating class at Waterloo Community Unit District Number 5 High School in 1979.

Holly received her Bachelor of Science, Summa Cum Laude in Speech and Hearing Sciences from Bradley University in 1982. She received her Master of Science in Audiology from Gallaudet College in 1984. She obtained her Certificate of Clinical Competence in Audiology in 1985. Holly worked as a clinical audiologist in a variety of settings prior to being accepted into the University of Florida, College of Liberal Arts and Sciences for graduate studies in 1990. She is currently employed by the American Speech-Language and Hearing Association in the Audiology Division.

Ms. Kaplan married Ray M. Kaplan in June of 1986. They have two children, Elyssa Rose born March 20, 1990, and Harrison Michael born January 4, 1995.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Alice E. Holmes, Chairman
Associate Professor of
Communication Processes
and Disorders

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Walter R. Cunningham
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Professor of Anthropology

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